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**A Strategic Analysis of Pricing Strategies When
Consumers are Inequity Averse**

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“The aim of justice is to give everyone his due.”

Cicero

“But the difficulty of distinguishing good quality from bad is inherent in the business world; this may indeed explain many economic institutions and may in fact be one of the more important aspects of uncertainty.”

George A. Akerlof

Abstract

In many situations, firms have an incentive to charge different prices to different consumers. A price discrimination strategy aims at exploiting differences in consumers' willingness to pay in order to increase the firm's profit. At the same time, consumers often evaluate a purchase transaction with respect to the perceived (un)fairness regarding the terms of the transaction, prices or qualities provided. If consumers are inequity averse to the extent that they care about whether other customers pay a lower relative price per quality, a quality-based price discrimination may turn out less profitable than if consumers act selfishly.

The dissertation project analyzes the impact of consumer social preferences on the implementation of different pricing strategies in monopolistic and duopolistic markets. It accounts for asymmetrically distributed information about product quality and emphasizes the optimal signaling strategies in a monopoly. Additionally, quality-based price discrimination is identified as the optimal strategy to eliminate potential competition under perfect information. In the context of third-degree price discrimination, the effect of inequity aversion on quality choices is analyzed.

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List of Variables

i	A, B	Type of the firm
j	l, h	Level of product quality
q_j	$0 \leq q_L \leq q_H = 1$	Product quality
c_i	$0 \leq c_A \leq c_B \leq 1$	Variable costs of firm or type i
μ	$0 \leq \mu \leq 1$	Consumer belief that the monopolist has low costs
m	$m = \mu + (1 - \mu) q_L$	Medium expected level of quality
p_j^i	$0 \leq p_j^i$	Price charged by type i for quality j
δ	$0 \leq \delta \leq 1$	Inverse discount
θ	$0 \leq \theta \leq 1$	Consumer preferences for quality
γ	$0 \leq \gamma \leq 1$	Strength of social preferences
m	$1, 2$	Name of the market
p_m^i	$0 < p_m^i$	Price of firm i charged in market m
q_m^i	$0 \leq q_m^i \leq 1$	Quality offered by firm i in market m

1

Introduction

1.1 Motivation

Surprise was the reaction of many consumers recently visiting a Media-Markt store – a German based consumer electronics retailer¹. While the regular price for a specific memory card was €29, the same item was offered for a special price of €11 in another part of the same store. Further price differences for the memory card were observed in the online shop (Schneiders (2015) and Brand (2013)). In addition to that, the prices for many other products, such as television, vary daily. How can this price pattern be explained? Many online stores nowadays immediately adjust their prices as a response to changes in external factors, for instance demand, economic conditions or the launches of new products. In order to keep up with these price adjustments, Media-Markt modifies its prices in the online store as well, whereas prices in the bricks and mortar stores may be changed less often. More importantly, consumers buying online might differ from those visiting the stores, for instance in their knowledge about the product characteristics, their need for consulting experts or their income. For that reason, they may also have different reservation prices for the good and Media-Markt can improve its profit by exploiting these differences. Nevertheless, consumers who observed the price differences for the memory card felt upset and betrayed and reported their negative emotions in the internet (Gassmann (2015a)).

Customers of Media-Markt are not the only ones feeling annoyed by the price policy of a

¹ The company has stores in more than 800 locations in 14 European countries with revenues of €21 billion in 2013/2014 (see Metro Group Annual Report 2013/2014). It also features an online store.

firm. Allianz Global Investors is an international investment management company, managing more than €454 billion of invested money. They offer different products to individuals, such as equity funds or bond funds. In 2009, the company introduced performance-based fees for several of their investment funds. If the fund performed better than the considered benchmark, individual investors needed to pay a performance-based fee. Other investment opportunities, such as Exchange Traded Funds, were at that time introduced free of charge. Consumers reacted negatively to the introduction of the performance-based fee after they had experienced substantial losses during the financial crisis that started only one year before (see von Gaertringen (2009)).

Another interesting example about a specific pricing policy concerns the German supermarket chain Kaiser's Tengelmann. It's approximately 500 stores are located in Germany, creating a revenue of almost €2 billion in 2013 (see Tengelmann Warenhandelsgesellschaft KG Annual Report 2013). In order to improve its profitability in the highly competitive German food market, the company launched a customer card, called "ExtraKarte" in June 2014. Participants are granted customized discounts for particular items when entering the supermarket and inserting their ExtraKarte into the machine. The consumer receives a coupon with several discounts offered for the shopping tour (for example "20% discount on strawberry yoghurt"). Data about past purchases is stored on the card, while other personal information (such as the name or the age of the customer) remains private. The algorithm suggests price discounts based on the past purchase behavior and inferred preferences of the customer. After the successful test in 30 Berlin stores with more than 60.000 active users, Kaiser's Tengelmann decides to extend the strategy to more than 150 stores in Berlin and Brandenburg (Werner (2014) and Tengelmann Warenhandelsgesellschaft KG (2015b)).

What do these three examples have in common? What are the reasons for the differences in the consumer behavior? Why do firms choose multiple prices for similar or even identical items? Why are the price differences enforced by Media-Markt not as successful as those implemented by Kaiser's Tengelmann? The three cases all describe particular interactions between firms and customers. They address the topic of price differences across time or across consumers and the potential (negative) reactions of consumers who observe these

differences. The example of Allianz Global Investors highlights that consumers are not always willing to pay a higher price for a product with a superior performance. To the contrary, the introduction of performance-based fees has even led to negative publicity for the firm due to consumers' outrage.

The two examples about Media-Markt and Kaiser's Tengelmann deal with the desire of firms to charge the highest price each consumer is willing to pay, also called price discrimination². Media-Markt attempts to implement the price discrimination strategy on an aggregate level – for instance by charging different prices on different days of the week or by setting other prices in the online channel. Contrarily, Kaiser's Tengelmann customizes discounts for each participant of the ExtraKarte program, requiring a more detailed analysis of customer behavior and inferences about the underlying preferences. The price differences at Media-Markt can be observed by any customer but those enforced by Kaiser's Tengelmann are less obvious.

While the strategy of Kaiser's Tengelmann turns out yet to be successful, the pricing strategies of Allianz Global Investors and Media-Markt have partly dissatisfied consumers. One explanation for the negative reactions in these two examples and the positive reaction in the case of Kaiser's Tengelmann is given by the theory on social preferences that incorporates non-economic components into the utility functions of individuals.

1.2 Aims and Methodological Approach

All of the examples above illustrate that consumers are not only concerned about the material payoffs resulting from a transaction – be it a financial investment or a purchase. If this was true, they would only evaluate the price paid for the memory card at Media-Markt, for example, but not the other prices for similar products. Consumers often perceive transactions as *(un)fair* in terms of the price-performance ratio, the service quality or the profit realized by the seller, which – according to the standard economic assumption of *homo oeconomicus* – should not influence their utility. Nevertheless, it often does and by that affects consumer behavior. One of the most relevant influencing factors is the price for the good which individuals might perceive as too high or too low relative to those charged for other products or prices paid by other consumers. Contrarily, firms want to improve

² A more detailed definition of the term price discrimination is provided in Section 2.2.

their profits by setting a higher price for those consumers who are willing to pay more.

A key driver for these developments in pricing strategies are the technological advances. On the one hand, the internet enables firms to learn more about their consumers, such as their demographic characteristics, individual preferences and shopping habits. The technological development thus allows firms to collect, store and analyze customer data at substantially lower costs (Rossi et al. (1996)). On the other hand, the internet also facilitates the comparison of prices for consumers without incurring high search costs. In addition to that, consumers now use the internet as a communication channel to disseminate their opinion about dissatisfying shopping experiences. One dissatisfied customer may thus induce a boycott of many individuals by sharing his experience with others online.

The desire of firms to set prices according to the individual willingness to pay of customers is therefore opposed to the desire of consumers to engage in a “fair” transaction with a seller. While Media-Markt can increase its profit from charging different prices in the online store, consumers might be annoyed and by that experience some form of disutility. This trade-off has been – and is likely to become further – intensified by the technological development.

For that reason, the dissertation project aims at analyzing the influence of so-called social preferences (and in particular disadvantageous inequity aversion) on the optimal pricing strategy of firms and thus the trade-off between firms’ increase in profits from charging different prices to different consumers and consumers’ disutility from feeling treated unfairly. How do social preferences affect the optimal prices and quality choices? What is the adequate pricing strategy when consumers do not know the quality of the product ex-ante? Do firms and consumers suffer when social preferences affect the individual utility?

These questions are crucial for firms and consumers in many transactions. That is why the thesis aims at incorporating the fact that consumers deviate from the assumed purely selfish behavior and specifying the consequences of these deviations for the behavior of consumers and firms. It analyzes the impact of social preferences, in particular the disadvantageous inequity aversion, on pricing strategies in different contexts. The thesis contributes to better understand the implications of social preferences for firms and consumers – where most research is of empirical and experimental nature – on a *theoretical*

level. Moreover, it studies the role of asymmetrically distributed information about the product quality on the pricing decision. By that, the thesis extends current research on the price signaling of quality by augmenting the firm's strategic scope for quality choices.

In order to address these topics, different game-theoretical models are developed and analyzed. Both a monopoly and a duopoly are studied with different assumptions on the distribution of information and the type of price discrimination. The methodology used throughout the thesis has several advantages. It reduces the scope of the research question to its most basic features and derives theoretical results. The general character of the findings allows the application to a multitude of products, firms and industries. In addition to that, it provides researchers with a profound theoretical basis for further empirical and experimental studies.

1.3 Structure of the Thesis

The thesis first begins with an analysis of the current state of research (Section 2) and then continues with three models: a model with asymmetric information in a monopoly (Section 3) and two models with perfect information and competition (Sections 4 and 5). Section 6 discusses the findings and Section 7 concludes the thesis.

The analysis of the literature (Section 2) discusses and evaluates the most important theoretical, empirical and experimental studies that relate to the topic of the thesis. In particular, three major areas are of concern; namely the product characteristics, firm strategies and consumer characteristics. The relevant research on product characteristics mostly incorporates game-theoretical models that analyze the sources and consequences of consumers' uncertainty before the purchase about the true quality of goods (Section 2.1). In order to reduce the uncertainty, firms can utilize different instruments to convey information to consumers about the true quality (see Section 2.2.1). Additionally, firms always must decide on the optimal price(s) for their good(s). One key strategy involves price discrimination, where different consumers pay different prices. Due to the technological advancements, this strategy gains increasing importance (Section 2.2.2). However, consumers are often dissatisfied when firms enforce a price discrimination strategy. Section 2.3 addresses the impact of individuals' non-economic preferences and deviations from the standard game-theoretical assumption of purely selfish consumers, in particular with re-

spect to the fairness perceptions of prices. Finally, the current state of research is critically assessed and potential gaps are identified (Section 2.5).

The first model derived in Section 3 addresses the role of quality uncertainty and social preferences for the optimal pricing strategy in a monopolistic market. It is based on the assumption that the monopolist has either high or low cost and by that can offer different quality levels. A second-degree price discrimination strategy can be implemented by offering two quality levels. In order to capture the long run effects, the model incorporates two consumption periods, so that consumers can learn about the true quality through consumption and then decide whether to purchase a second product. While Section 3.3 examines the benchmark case of perfect information, Section 3.4 solves the signaling game by deriving the different pooling and separating equilibria under asymmetric information. Results are summarized in 3.5, whereas the comparative analysis in Section 3.6 takes a look at the influencing parameters. The overall results are interpreted in Section 3.7.

The following Sections 4 and 5 study two duopolistic models. The first one (Section 4) translates the monopoly model to a competitive environment. The two cost types introduced in the monopoly model are now assumed to be two firms that compete in prices. For simplicity, the model is analyzed under perfect information, so that consumers can perfectly assess the product quality ex-ante. Moreover, the cost advantage of one firm leads to two potential market structures that can evolve endogenously. The results are presented in Section 4.4. The comparative analysis (Section 4.5) identifies the key drivers of the findings. An overall interpretation is given in Section 4.6, while the limitations are discussed in Section 4.7.

The second duopolistic model (Section 5) considers a third-degree price discrimination and examines the optimal price and quality choices of the two firms. It assumes that one firm serves two separate market segments, while the other one is active in only one segment. By that, it differs from the first two models in various aspects and concentrates on the impact of social preferences on the endogenous quality selection. The comparative analysis in Section 5.4 identifies the impact of social preferences on the quality and price decisions as well as the implications for consumer surplus, firm profits and social welfare. The results are interpreted in Section 5.5, whereas limitations are addressed in Section 5.6.

Section 6 provides an overall discussion of the findings from the three models. Their

contributions to the current state of research are examined in Section 6.1. Since the three models share some common characteristics, they are also subject to similar limitations. Those limitations that apply to at least two of the models are reviewed in Section 6.2³. Finally, the implications of the models are adressed – both for practitioners (Section 6.3) and for researchers (Section 6.4). The last part of the thesis is an overall conclusion which is drawn in Section 7.

³ Limitations that relate to only one model are discussed in Sections 4.7 and 5.6, respectively.

2

Analysis of the Literature

The examples presented in the beginning illustrate the role of fairness concerns in the consumers' perception of prices and the potential consequences on their decision making: Consumers do not only assess a transaction in terms of the price paid and the quality or quantity received, as highlighted by the example of Media-Markt. Instead, they also consider for example the friendliness of service personnel, the speed of delivery or the perceived fairness of prices. For that reason, the three models developed in this work analyze the potential effects of social preferences on price discrimination strategies, both under quality uncertainty and under perfect information. Before presenting the game-theoretical model, the literature analysis assesses the current state of research. It identifies the pricing strategy (and in particular, price discrimination) as an attractive driver of firm profitability and points out the negative side-effects of particular price patterns on consumers. By that, the literature analysis integrates the insights from theoretical and empirical works in order to identify potential gaps that will require more attention from future research. The major gap, namely the incorporation of social preferences on the profitability of price discrimination, is the subject of the dissertation project.

The first part of the literature analysis (Section 2.1) concerns the characteristics of a good – in particular the uncertainty about its quality which constitutes an important aspect of the model presented in Section 3. The second part (Section 2.2) examines how firms can optimally respond to the ex-ante uncertainty of consumers. The variety of reactions of customers to the behavior of firms is discussed in the third part (Section 2.3). Finally, the

current state of research is evaluated, providing evidence that the following models address important topics not yet adequately covered.

2.1 Product Characteristics

In many markets, consumers and producers have different pieces of information about various aspects of the transaction, so that there is an information asymmetry (Jost (2014)). On the one hand, consumers might know more about their preferences, how often they will use the good or how they will treat a good after the purchase. On the other hand, firms might have more information on the costs of production, true characteristics or the superiority compared to competing products than consumers have before the purchase. In particular, there might be ex-ante uncertainty on behalf of consumers about a product's quality (where quality includes all attributes the consumer values, such as the taste, design or durability, see Liebeskind and Rumelt (1989)). If consumers cannot judge the quality of a good at first sight, they must seek additional information – either by search (ex-ante) or by experience (ex-post), as pointed out by Nelson (1970).

Depending on the level of information consumers have about product characteristics, various types of goods can be identified. Nelson (1974, p. 730) therefore distinguishes between goods with search qualities which consumers “can determine by inspection prior to purchase of the brand” and goods with experience qualities “that are not determined prior to purchase”. Water is a search good, because consumers exactly know the characteristics before the purchase. Contrarily, having dinner in a restaurant describes an experience good because customers cannot judge the taste of the meal, quality of ingredients or the size of the portions when ordering their preferred menu. For credence goods – a term introduced by Darby and Karni (1973) – quality cannot be perfectly determined even after the purchase, such as in case of medical services or car repairs. Most products exhibit several types of characteristics; a car has search qualities (for example color), experience qualities (actual fuel consumption) and credence qualities (safety in car accident). In the following, the term “search good” will be used for those goods where consumers are able to assess the quality before the purchase. Similarly, the term “experience goods” will be used to describe those goods that mainly feature experience qualities, so that consumers

do not know the quality ex-ante but perfectly learn it ex-post¹.

Although consumers can generally seek additional information before the purchase, they are not always successful in perfectly assessing the quality without consumption. Search costs might be too high to perfectly infer the qualities of all products offered in a market or consumers might not be sure whether the obtained information is correct (Andersson (2002)). Consumers cannot judge the quality of a detergent before the purchase but might read independent product tests, consult the service personnel at the store or search for consumer reports in the internet. It is unlikely, however, that the high search costs justify the comparably low price for detergents, so that the consumer is rational not to collect as much information as possible about the detergent but simply try one. Consumers can also use the recommendations of experienced consumers in order to better assess the quality before purchase. However, the recommendations are only useful when preferences of consumers are correlated and the product features are actually the same for all units sold (see Nelson (1970)). These are major reasons why consumers cannot evaluate the quality of many goods without incurring substantial costs before the purchase (Darby and Karni (1973)).

Apparently, the characteristics of a good do not only affect the level of search costs but in turn also influence the firm's strategy (Homburg and Krohmer (2009)). New products, for instance, could be launched at a special price, inducing consumers to try the unknown good. In addition to that, the advertisement of a search good might contain different information about the product characteristics than the advertisement of an experience good which focuses more on emotional aspects, as pointed out by Nelson (1974). If a firm sells an experience good, it may have an incentive to decrease the uncertainty and implement different instruments to better inform its customers. In the following, the different causes and consequences of consumer ex-ante uncertainty on product features are outlined.

2.1.1 Causes of Quality Uncertainty

In many situations, consumers (and sometimes even firms) are not sure before the purchase transaction whether the true characteristics of the product will be as expected. There are several causes for quality uncertainty in case of experience goods. On the one hand,

¹ Since credence goods will not be part of the theoretical models, they will not further discussed in detail here.

consumers sometimes make mistakes when judging the quality of a product (Rogerson (1983)) or they learn their true preferences only after consuming the good (Villas-Boas (2006))². If the production technology is imperfect, some of the products sold are defective and firms cannot always sort out the defective units before selling them. For some reasons, food can perish before the expiration date but the producer might not anticipate the reduced quality when the product is delivered to the supermarket.

More often, however, the uncertainty results from the firm's strategic decisions not to disclose all available information about the product quality, such as the comparably low expected product life time measured in tests before the market launch. Another influencing factor is the heterogeneity on the producer side of the market: if different "types" of firms exist in a market that sell different quality levels, they may not always be able or willing to reliably communicate the true product characteristics to consumers (Stiglitz (1989)). A producer of earphones has no incentive to communicate to consumers that tests revealed an expected durability of only 12 months. Instead, a high quality producer might want to claim the extraordinary sound quality of its product in order to increase their willingness to pay. But why should consumers trust this claim if other brands with similar statements sell only low quality?

The uncertainty regarding product quality also depends on the extent to which firms can define the characteristics of their goods. In some models, the firm can directly choose the quality sold (Klein and Leffler (1981))³, or at least whether to use a good or a bad production technology, as assumed by Liebeskind and Rumelt (1989) and Allen and Faulhaber (1988). Other models (specifically those in the context of quality signaling) assume that quality is given exogenously and firms observe the quality of their own products before setting prices and other signals (for example Milgrom and Roberts (1986)). In the following, the term "quality uncertainty" is thus used to describe the informational advantage of firms vis-a-vis their customers in terms of the true characteristics of a product.

² According to Erdem and Keane (1996), differences in advertising signals and consumption experiences lead to an endogenous heterogeneity among consumers with respect to the expectation on product characteristics over time, despite identical ex-ante expectations of quality.

³ Under perfect information, the optimal qualities in a model of vertical differentiation are derived by Tirole (1988) and Choi and Shin (1992).

2.1.2 Consequences of Quality Uncertainty

The information asymmetry has various effects on firm strategies, consumer behavior and market characteristics. Due to its informational advantage, the firm can behave opportunistically and abuse the consumer's lack of information (Jost (2014)). In a one-shot game, a firm can set a high price and produce low quality instead (moral hazard). If prices in the market decrease as a response to consumer uncertainty, high quality firms leave the market (adverse selection) and the market could even fail (see Akerlof (1970)).

A key question concerns the optimal price for experience goods⁴. In a model with two firms and consumers who learn their preferences ex-post, Villas-Boas (2006) demonstrates that a firm selling high quality products can charge a lower price in the first period and a higher one in the second period. Firms can then gain an informational advantage by having a large market share in the beginning. However, the model demonstrates that market shares converge in the long run, as a higher market share induces a firm to charge higher prices and thereby leads to a relatively lower demand from new consumers. Assuming that health services constitute an experience good, Hoerger (1990) provides empirical support that new patients pay a lower price and learn about the quality of the service. When a patient visits the physician again, he should then be willing to pay a higher price.

The imperfection of information has further consequences for the market characteristics. By having superior information, the firm possesses some form of monopoly power of information (Cabralés and Charness (2005)), resulting in inefficiencies and a loss in social welfare. Additionally, search costs of consumers lead to a reduction in the variety of products (Stiglitz (1989)). Rogerson (1983) relates the product quality to the size of firms. He finds that high quality firms are larger, since satisfied consumers recommend the products and create additional demand. Low quality firms, contrarily, are smaller because they dissatisfy consumers who will then stop buying from the firm.

According to Nelson (1970), locations of firms are inherently related to the product quality. In the case of experience goods, consumer must try more goods in order to find the "right match". Nelson (1970) therefore presumes that stores selling experience goods are located less closely to each other compared to those selling search goods. In case of experience goods, quality cannot be determined before the purchase anyway and prices are

⁴ See Section 2.2.1 for further details on price signaling.

more difficult to compare which decreases the attractiveness for consumers to visit several stores. Contrarily, Bester (1998) argues that price competition is less severe for experience goods and this in turn leads to minimum horizontal differentiation in equilibrium: If both firms sell high quality, they must charge a price premium anyway and horizontal differentiation is no longer necessary to soften price competition. This would suggest a clustering of firms offering experience goods rather than of those selling search goods.

Further consequences of asymmetric information about product characteristics regard the market structure. Dana and Fong (2011) explain that oligopolies can sustain a high quality equilibrium due to the threat of reputational losses and discontinued tacit collusion. Competition, contrarily, reduces the price premium charged for high quality and thereby makes it more attractive for firms to switch to a low quality equilibrium. In a two-period model, Krähmer (2003) considers a different type of information asymmetry. Consumers learn their valuation of the new product after consumption but this information remains private. The author investigates the introduction of a new experience good of unknown quality to consumers which competes with a good of known quality. Due to the asymmetry of information, the firm selling a new experience good cannot incorporate the true utility of the good in the price. As a consequence, new experience goods are not sufficiently often introduced from a social welfare perspective.

2.2 Firm Strategies

2.2.1 Quality Signaling

As outlined above, quality uncertainty especially evolves when firms selling different quality levels are grouped together so that consumers cannot differentiate which quality they buy (see Stiglitz (1989)). Given that an individual's utility increases in the product quality, a so-called high quality firm often wants to reveal the superior product characteristics to consumers in order to raise their willingness to pay. Contrarily, a so-called low quality firm can benefit from the uncertainty by charging a comparably high price until consumers learn the true qualities. For that reason, a firm producing a lower quality rather prefers to hide the product features, while a firm selling high quality uses particular signals in order to

resolve quality uncertainty⁵. Although these signals differ in many aspects, they all have in common that they cause costs (so called information costs, Homburg and Krohmer (2009)) to the firm which wants to reveal its true identity, for example as a high quality producer. At the same time, other firms – such as low quality sellers – do not find it profitable to incur these costs as well, so that consumers can infer the type of the firm by observing which of them invests in the costly signal. Only if a firm realizes higher profits from signaling quality, it can make up for the initial investment in the long run. Game-theoretical models identify two forms of equilibria. Assuming that there are two types of firms on a market, a pooling equilibrium requires that both select the same action (for example set the same price), whereas a separating equilibrium implies that both types act differently. Only in the latter case, consumers can determine the type of the firm ex-ante. Some of the most important instruments to deal with quality uncertainty are discussed below.

Warranty

A warranty compensates the buyer when the product does not fulfill the promised quality, for instance due to a break down, and buyers no longer bear the risk of a defect product alone (Akerlof (1970)). If warranties are perfect, uncertainty is removed and consumers effectively buy a search good (Tirole (1988)): Even if the product turns out to have a bad quality, consumers receive a new one or a (financial or material) compensation, so that their consumption utility is not decreased.

Theoretical research has studied the role of warranties in several contexts. Kubo (1986) assumes that the monopolist's product breaks down with an exogenously given probability. He shows that an optional guarantee (as opposed to a good without guarantee or a good with tied-in guarantee) can be used as a discrimination device. Only consumers with a higher income buy the optional guarantee. In equilibrium, the firm decides to offer the product with an optional guarantee if the income differences are sufficiently high. In a similar vein, Gal-Or (1989) examines the case in which the firm can signal its product quality only through the length of the warranty. The product quality is given and firms

⁵ Consumers can also search for additional information and screen the market to find the appropriate quality. Nevertheless, the level of search costs, the availability and the verifiability of information about the good limit the consumers' ability to effectively distinguish between different qualities (Homburg and Krohmer (2009)).

compete in quantities (assuming that the output is not observable to consumers). A firm with a more durable good might offer the longer warranty in equilibrium. However, if the expected durability of the low quality good is comparably low or high, the firm selling the less durable good offers the longer warranty. In both cases, consumers learn the quality ex-ante through the length of the warranty, because knowing the particular cost levels allows them to distinguish between the two separating equilibria. The model of Lutz (1989) applies a different approach by assuming that the probability of a product break down is also influenced by the consumer's maintenance effort which is unobservable to the monopolist. If the consumer observes the exogenous product quality before the purchase, the monopolist only provides a partial warranty. Whether the warranty is higher for low or high product quality is ambiguous. If consumers cannot observe the quality ex-ante, they can always infer it from the offered price and warranty contract, since pooling equilibria do not exist in this model.

Warranties have some disadvantages, though. Anticipating the costless replacement of a defective item, consumers may handle the product inappropriately (moral hazard). As a consequence, firms providing warranties may attract exactly those consumers who use them in such way (adverse selection). Firms can counteract both issues by only providing partial warranties (Allen (1984)). In this context, Allen (1984) shows that firms might set prices below marginal costs. Nevertheless, partial warranties can involve other problems, such as the enforcement and measurement (Liebeskind and Rumelt (1989)): When exactly is a product "defective" and must be replaced within the scope of the warranty? How does the customer get a new one? These problems show that warranties might not always be the optimal instrument for firms to efficiently resolve the quality uncertainty.

Advertising

Relative to warranties, advertising does not change the underlying value of a good but can instead reduce search costs of consumers by providing information about the product before the purchase. It is one of the most prominent form for observable fixed costs which only high quality firms are willing to invest, since they are able to recuperate the investment through a price premium (Rogerson (1983)). Other related investments include store locations or sponsoring activities and many of the insights from models incorporating advertising may

be transferred to these other types of fixed costs.

One key difference between the theoretical models on signaling with advertising is how and to what extent advertising informs consumers who are ex-ante uncertain about product quality. Following the intuition of Nelson (1974), Milgrom and Roberts (1986) develop the first model in which the monopolist can apply both the dissipative advertising⁶ and the price as a signal of its product quality which is exogenously given. Advertising (here modeled as an investment observed by consumers) is used as a signal of quality if the cost differential between high and low quality is not too large. Hertzendorf (1993) uses a more realistic approach in modeling advertising as a stochastic variable in a monopoly. Consumers who do not see an advertisement might infer that the quality is low and unwilling to buy the good at a high price. Given that price and quality are correlated, the author shows that advertising is only used when the two types pool in prices, as it does not convey any additional information if the types already set different prices⁷. Contrarily, if a small fraction of consumers in a competitive market with a high and a low quality seller is informed about qualities before the purchase, Yehezkel (2008) ascertains that the high quality duopolist still invests in uninformative advertising, while it does not advertise if a medium fraction of consumers is informed. In this case, the high quality firm separates by using only the price as signal. Both firms obtain the highest profits if only some consumers are informed ex-ante.

Despite the differences in modeling advertising and in the effects on consumer behavior, a common feature concerns the impact on welfare. If advertising only serves to signal the true quality of a good, firms often invest excessively and thereby reduce social welfare. This “burning of money” constitutes a substantial disadvantage of implementing advertising as a quality signal (see Tirole (1988)).

Reputation

Reputation refers to “consumer’s beliefs about a firm’s future behavior based on its past and present actions” (Liebeskind and Rumelt (1989, p. 602)). The reputation mechanism

⁶ Dissipative advertising does not convey objective information about product features to consumers. It is also called “uninformative (or persuasive) advertising” and opposed to the “informative advertising” featuring objective information on the product attributes (see Bagwell (2001)).

⁷ Moraga-González (2000) also analyze the case in which the two types endogenously determine the fraction of informed consumers through advertising. Due to the underlying assumptions, however, the analysis only finds pooling equilibria if consumer valuation is sufficiently high.

can work across products (for multi-product firms) and across time.

In the first case, the reputation of one product might spill over to another product. A consumer who is satisfied with the quality of his new walking shoes updates his expectations on the quality of the trekking backpack of the same brand. This phenomenon of umbrella branding requires that the products are sold using the same brand name so that consumers can make inferences about the quality of one good after having experienced another good of the same brand.

Several game-theoretical models support the positive effects of umbrella branding. It provides a solution to the moral hazard and adverse selection problems in markets with quality uncertainty. In a moral hazard setting, Hakenes and Peitz (2008) find that umbrella branding is used in a high quality equilibrium for medium levels of the detection probability and medium levels of costs. More generally speaking, high quality firms only employ umbrella branding if the detection probabilities of the two goods are sufficiently similar⁸. However, the researchers abstract away from other quality signals, as firms do not set prices strategically⁹. An earlier model by Wernerfelt (1988) does not suffer from this major limitation of Hakenes and Peitz (2008) and allows firms to use the price as an additional signal. Supporting the strength of umbrella branding in an adverse selection environment, this model picks up the idea that a firm which has already established a reputation with an existing product introduces a new one and sells both of them in a second period. In the end, umbrella branding is only used by firms selling two high quality products, while prices are the same for all firm types. Andersson (2002) demonstrates that the use of umbrella branding might sometimes even be required for launching a new product in a market, because the high quality claim would otherwise not be credible.

Umbrella branding has both advantages and disadvantages. From the consumer perspective, the familiar brand name reduces the risk of purchasing a product of unknown quality and firms can economize on the costs of establishing a brand (Cabral (2009)). However, if products are sold under the same brand name, the breakdown of one product also deteriorates the sales of another product (Cabral (2009))¹⁰. Additionally, if consumers

⁸ This further implies that umbrella branding might not work for products with very different levels of search, experience and credence qualities.

⁹ In their model, there are enough consumers who bid for the offered good in an auction which is in turn sold at a price equal to the reservation price.

¹⁰ This is why umbrella branding constitutes a credible signal of product quality, see Erdem and Sun (2002).

do not feel that the new product fits the old one, the perceived quality can decrease, as pointed out by the empirical study of Erdem (1998). Interestingly, the study also provides evidence that this so-called carry-over effect works in both directions if goods are launched sequentially: the perception of an old product can also be altered through the introduction and consumption of a new one.

Despite the effect of reputation across products, it can also be considered in a temporal dimension. In this case, the eventual loss of future sales once that low quality has been distributed provides a rationale for firms to offer high quality from the beginning on. Consumers lose their confidence in the firm if it has deviated to a low quality strategy and will not pay a high price again. Klein and Leffler (1981) demonstrate that a price premium is a necessary requirement for sustaining a reputation for high quality, so that a firm has no incentive to offer low quality and benefit once from an improvement in profitability. They observe that consumers are willing to pay a higher price after quality is verified and to repurchase again. Since the premium would invite new firms to enter the market, the authors argue that firms compete in other dimensions than price and deter entry in this way. The model of Allen (1984) overcomes this limitation of non-price competition. Consumers are assumed to know the cost functions of firms and observe their outputs, thereby inferring the sold quality. Firms can still charge a premium for high quality because a price reduction would accordingly change the consumers' quality expectations and lead to zero purchases.

The implementation of a reputation mechanism over time does not only depend on the profitability for firms but also on the expectations of consumers. If, for example, consumers are too optimistic about the expected quality, firms might find it attractive to deviate to low quality. This intuition is studied in a game-theoretical model by Allen and Faulhaber (1988). By introducing noise in the production process, the authors investigate the case in which the quality of production technology and the quality of output are not perfectly correlated. If consumers expected the firm to use a good machine with certainty, the firm would be better off to buy a bad one and sell low quality. Hence, for perfect selection of production technology (that is, the firm receives the desired technology for sure), only low quality survives in equilibrium. Only if firms actually receive a good technology with some probability smaller than 1, a high quality equilibrium can exist because consumers are skeptical enough and have lower ex-ante expectations of quality.

Price

Given the ex-ante uncertainty of consumers, firms can also use prices to convey information about the product in question. In this case, prices do not only reflect the demand conditions anymore (as in case of full information). According to Stiglitz (1989), they are stickier and serve as a barrier to entry. Price signalling means that firms selling distinct goods set different prices in equilibrium, so that consumers can correctly infer the characteristics of the good sold by each type. Narasimhan (1984) suggests that firms should internalize the information costs caused by quality uncertainty and thereby offer higher coupons for new goods. Since repeat buyers learn about their willingness to pay for the given quality, the firm can then charge a higher price, as indicated by the formal model of Milgrom and Roberts (1986). Liebeskind and Rumelt (1989) also take into account that consumers stop purchasing a good if they receive bad quality. They show that a discount can convince consumers to buy the good in the beginning, but higher prices in the following periods make up for the up-front losses as long as high quality is sold.

A different view on the price development over time is given by the formal model of Bagwell and Riordan (1991). It distinguishes between informed and uninformed consumers. A firm selling high quality separates in equilibrium by charging a high price. Contrarily, a pooling equilibrium only exists if the proportion of informed consumers is in a medium range. Interpreting their static model in a dynamic way, the authors infer that prices for high quality decrease over time, since more consumers become informed about the actual quality. The model of Hoerger (1993) also accounts for consumer heterogeneity by distinguishing new customers and repeat customers. In this scenario, he finds that a high quality monopolist should optimally introduce a two-part pricing strategy with a low price charged to new customers and a higher price to repeat customers, while a low quality producer should employ a reverse schedule. The monopolist effectively discriminates among consumers.

Summing up, the pricing strategy plays a major role for experience goods, because it conveys information on the characteristics of the products. It is a key lever of profitability (Simon and Fassnacht (2008)) for search, experience and credence goods. One particular pricing strategy, namely price discrimination, accounts for heterogeneity among consumers in terms of their willingness to pay, as emphasized by the model of Hoerger (1993). Price

discrimination is also a major aspect of the models presented in Sections 3, 4 and 5 and thus discussed in more detail below.

2.2.2 Price Discrimination

Price discrimination has been a major topic in the past, both for theoretical and empirical researchers, and in many cases, the findings and implications are still contradicting. According to Armstrong (2006, p. 1), price discrimination is given “when two ‘similar’ products with the same marginal cost are sold by a firm at different prices”. This definition highlights that goods offered at different prices must be perceived as homogeneous and comparable by consumers. It also points out that sometimes differences in prices may be due to corresponding differences in costs, for example due to the delivery or customization of the good or due to differences in qualities, in which case the firm does not discriminate among its consumers (Stole (2007)).

Apart from the specifications given by the definition, firms must account for additional aspects when thinking about whether to implement a price discrimination strategy. Varian (1989) presents three requirements for price discrimination. *First*, the firm must have some sort of market power. In a perfectly competitive environment, firms can only charge a price equal to the marginal costs, leaving no opportunity to charge different prices to its consumers. *Second*, the firm must be able to identify and distinguish consumers in some way. The required consumer heterogeneity can either be observable (for example age, gender) or unobservable (for example preferences, income, search costs). In the first case, the segmentation is mostly given exogenously and is thus outside the scope of the firm¹¹, while in the second case, consumers often endogenously self-select into particular segments. The firm’s decision whether to price discriminate is therefore also related to the question of how (and how much) information about the potential customer base can be gathered (Armstrong (2006)). The technological development has facilitated the acquisition of customer information and enhanced the precision of firms to target their customers (Liu and Serfes (2005)), leading for instance to the increasing implementation of dynamic pricing in retailing. The *third* requirement which Varian (1989) mentions concerns the arbitrage: the successful implementation of price discrimination requires that consumers cannot resell

¹¹ The firm can only determine the boundaries of a segment, for example reduced prices for all persons under 18, but not the individual realization of the segmentation variable.

their goods to other consumers. Otherwise, consumers with a low willingness to pay can make a profit from buying a good at a low price and selling it at a higher price to consumers with a high willingness to pay¹².

In addition to the three conditions for price discrimination outlined by Varian (1989), Simon and Fassnacht (2008) emphasize that the consumers within a segment should be homogeneous, whereas the segments should be heterogeneous with respect to the underlying discrimination characteristics. They further list four requirements regarding the segmentation criteria. First, these criteria should be relevant for the behavior of consumers. Second, they need to be observable and measurable. Third, the individuals' realization of the segmentation criteria should not be subject to frequent changes but be stable over time (for example people wear shirts of different colors, so that this does not constitute a meaningful criterion for a market segmentation in the long run). Last, the authors claim that the chosen criteria should be related to the market instruments used for implementing the price discrimination strategy.

Price discrimination has benefits and costs. A firm might increase its profit by better extracting the consumer surplus. While some consumers pay higher prices, others might enjoy lower prices both in monopoly and duopoly (Holmes (1989)). In any case, firms incur internal and external costs by implementing a price discrimination strategy (Fassnacht and Mahadevan (2010), Anderson and Simester (2001), Liu and Serfes (2005)). Internal costs include operational costs (for example printing coupons) and costs for market research in order to identify customer characteristics. External costs involve reduced quality perception and negative reactions on behalf of consumers, such as fairness concerns (Lo et al. (2005)). In the extreme, a firm might even prefer a uniform price schedule if negative reactions substantially lower the willingness to pay, as shown by Anderson and Simester (2001). If the costs outweigh the benefits, price discrimination can reduce the profits.

The effects of price discrimination on profits and welfare are multi-faceted and very complex, especially when it comes to competitive markets. A monopolist will only price discriminate if it leads to higher profits than a uniform pricing schedule. These implications from monopolistic markets cannot be directly transferred to oligopolies, because the interdependence of firms' pricing decisions would be neglected. Whether price discrimina-

¹² The consequences of arbitrage on a price discrimination strategy are considered in a formal model by Jeon and Menicucci (2005).

tion enhances profits in a competitive setting depends on the form of heterogeneity among consumers, the products and the price discrimination instruments, see Stole (2007). Armstrong (2006) and Stole (2007) provide thorough discussions about the consequences of price discrimination on firm profit, consumer surplus and social welfare.

There are different forms of price discrimination. Stole (2007) discerns interpersonal discrimination (where a firm discriminates across consumers) and intrapersonal discrimination (where a firm discriminates across units but each consumer is offered the same schedule). The most common distinction is originally based on the seminal work of Pigou (1920)¹³. It identifies first, second and third-degree price discrimination. Another specific form of price discrimination is based on the consumers' behavior, receiving increasing attention due to the technological advancements and the rise of online retailers. These types are discussed in more detail below¹⁴.

First-Degree Price Discrimination

First-degree price discrimination describes the perfect extraction of consumer surplus. For every unit of output the firm charges the maximum price that the individual consumer is willing to pay (Varian (1989)). In a monopoly, the firm maximizes its profit by appropriating the whole gains from exchanging goods. Since consumer surplus is zero, this monopoly outcome is Pareto efficient. Stole (2007) further finds that in oligopoly, first-degree price discrimination leads to excessive entry and industry profits might fall compared to uniform pricing. Perfect price discrimination can be illustrated by the example of a bazaar or price negotiations about a new production facility customized to the needs of the client, where sellers bargain with each potential client individually on the price. In this process, sellers attempt to identify the buyer's reservation price and to maximize their profits.

However, in most situations the perfect discrimination is not applicable for two reasons. On the one hand, the firm might not have sufficient information about the consumer and is thus unable to set the prices precisely enough. On the other hand, the firm cannot credibly commit to its "take-it-or-leave-it" price schedule. In any case, the firm would still prefer to sell another unit at a slightly lower price than the first offer instead of not selling the

¹³ Another distinction from the management perspective is provided by Png (2013) who distinguishes between complete discrimination, direct segmentation and indirect segmentation.

¹⁴ Other specific forms of price discrimination include advance purchase discounts or product bundling which will not be presented within the scope of this work.

unit at all (Armstrong (2006)). These two major problems limit the implementation of first-degree price discrimination in real-life situations; it constitutes a rather abstract form and benchmark for theoretical considerations.

Second-Degree Price Discrimination

Second-degree price discrimination is characterized by a non-linear price schedule. All consumers are offered the same price schedule but prices differ per quantity or quality and customers decide which good they prefer. Common examples of second-degree price discrimination are the quantity-based and the quality-based price discrimination. In the first case, a firm charges different prices for large and small package sizes, where some individuals prefer to buy larger packages, while others prefer smaller ones. In the second case, goods of different qualities are sold at different prices. Individuals can read some articles of news magazines for free online, whereas more detailed reports are available only for registered customers who pay a monthly fee (“paid content”). If consumers can decide where to buy the good, the second-degree price discrimination can also have a geographical dimension. The self-selection into different segments is caused by consumer heterogeneity which, according to Stole (2007), can relate to both vertical and horizontal characteristics.

This mechanism has several advantages. It provides firms with an easy and inexpensive opportunity to identify different consumer segments when other differentiation characteristics are too costly to be applied or simply not available (Phlips (1983)). Consumers strategically respond to the menu offered by the seller by selecting their preferred option (Acquisti and Varian (2005))¹⁵. Nevertheless, second-degree price discrimination also goes along with a cannibalization problem (Stole (2007)). The demand (and thus the price) for a product is directly dependent on the price set for the other product(s). For that reason, a product does not only compete with goods sold by competitors but also with those sold by the same firm featuring a different quantity or quality level (Moorthy (1984)). The cannibalization problem alters the firm’s optimal price and quality choices. One solution to the competition between products of the same firm is a reduction in the offered variety. This endogenous aggregation of different consumer segments in the absence of economies

¹⁵ In case of first or third price discrimination, consumers can only decide whether or not to buy the good at the offered price.

of scale or scope is pointed out by Moorthy (1984)¹⁶. Otherwise, excessive cannibalization would reduce the monopolist's profit.

In addition to that, price discrimination can have further consequences on the product quality provided by the monopolist. In a seminal paper, Mussa and Rosen (1978) show that consumers in a monopoly with vertical differentiation¹⁷ receive lower quality levels than in an oligopoly if the firms price discriminate based on quality. The rationale for this observation is the following: since customers can switch between different quality-price combinations, the monopolist cannot charge a too high price for the highest quality. Furthermore, it might decide not to serve customers with the lowest preferences for quality: selling to consumers with a low willingness to pay requires a very low price, which in turn would induce other consumers with a medium taste for quality to switch to the lower product variant. This additional cannibalization effect of a price reduction can reduce the overall profit of the monopolist. As a result, the firm rather reduces the quality in order to achieve a higher profit, leading to the fact that all except for the high value consumers are provided with inefficient quality. As Srinagesh and Bradburd (1989) observe, this finding is caused by the assumption that consumers with a higher overall utility of quality also derive the higher marginal utility of quality. They generalize the findings of Mussa and Rosen (1978) by concluding that the segment with the lower total utility will receive an inefficient level of quality compared to the case of competition.

In a setting of quantity-based price discrimination, Jeon and Menicucci (2005) relax the assumption that customers do not arbitrage. Instead, two heterogeneous consumers can form coalitions (which cause transaction costs) where a neutral third party maximizes the sum of the two expected utilities. In this setting, the monopolist can suffer from customer coordination. The optimal sale mechanism, however, prevents arbitrage and results in the same profit as if arbitrage was not allowed. Coalitions could occur in equilibrium if consumers are better informed about each other's preferences than firms.

Using a spatial model with two competing firms, Desai (2001) assumes that consumers belong to either the high or the low value segment, where consumers of the same segment

¹⁶ Note that Moorthy (1984, p. 288) develops a model "based on the third-degree discrimination model of Pigou". Introducing a self-selection mechanism, however, would imply a form of second-degree price discrimination in the more modern typology. The lack of precision in delineating the different forms is discussed by Stole (2007).

¹⁷ In a model of vertical differentiation, consumers traditionally differ in their preferences for product quality or their individual income, while all would like a higher quality at a given price.

have identical vertical preferences. In each segment, consumers are furthermore distributed horizontally¹⁸. The two firms compete in prices and thus need to balance both the cannibalization effect from offering two goods to heterogeneous consumers and the influence of competition. If transportation costs of low value customers are smaller, competition is intensified and the cannibalization problem becomes more severe, because high value consumers find it increasingly attractive to buy the lower quality good.

The practical relevance of second-degree price discrimination is further supported by empirical evidence. Cohen (2008) emphasizes the existence of quantity-based price discrimination for consumer goods. Studying the different package sizes and prices for paper towels, he finds that 35-45% in the price variation is due to discrimination. Charging a uniform price per unit would lead to higher unit prices for larger package sizes and lower prices per unit for small packages. Verboven (2002) examines the quality-based price discrimination in three European car markets, considering the differences in prices for diesel and gasoline cars that cannot be explained by differences in production costs. Since consumers differ in the annual mileage, a seller can set a relatively higher price compared to production costs for Diesel cars that involve lower fuel costs (due to a lower fuel price and a lower consumption per mile). While individuals driving very much will find it profitable to invest in a diesel car, those with a lower annual mileage will prefer a gasoline one. The author finds that about 75% to 90% in the difference between prices for gasoline and diesel cars is due to the sellers' discrimination with respect to the heterogeneity in consumer mileage. Leslie (2004) points out that Broadway theaters can raise their profit by combining second (that is, different seat locations within the theater) and third-degree price discrimination (regular and discounted tickets) in an empirical study.

Third-Degree Price Discrimination

In case of third-degree price discrimination, consumers are assigned to different segments. Prices only differ across segments but not within consumers of the same segment. Moreover, individuals cannot switch from one group to the other. Common examples include

¹⁸ A model of horizontal differentiation assumes that consumers have an individual preference about a specific product characteristic and derive a disutility depending on how far the actual good differs from the ideal variant.

student discounts, where regular consumers pay a different price than students. Each segment pays the same price per unit, while switching is not possible. Third-degree price discrimination requires the firm to have sufficient information in order to correctly assign customers to a segment (if not given automatically) and to set the optimal prices based on these segments. The firm must also be able to enforce the segmentation and prevent customers from switching to another segment (Moorthy (1984)), such as denying young people a senior-citizen discount.

Many models assume that the segmentation is given exogenously (see for example Corts (1998)). The definition of consumer segments is a key concern for the seller, though, because it influences the optimal pricing strategy (Varian (1989)). Often, the segments (also called markets) are characterized with respect to their demand elasticities. The segment with more price-sensitive customers has a more elastic demand and is considered as the “weak market”, while the segment having a less elastic demand is called the “strong market” (Armstrong (2006)). It follows that the strong market pays the higher price and the weak market pays a lower price, according to Varian (1989)¹⁹. Corts (1998) shows that duopolists having different views on the market segments set prices asymmetrically, a finding commonly referred to as best-response asymmetry.

Lo et al. (2005) also assume that consumers are exogenously assigned to segments, but apply a different characteristic in the context of experience goods. The authors assume that consumers buying an experience good differ with respect to their knowledge about the product features: while some are able to assess the quality before the purchase better (so-called “experts”), others have no prior knowledge (“non-experts”). In this way, targeting the experts with a relatively lower price signals the non-experts the high quality of the good. By reducing the quality uncertainty to non-experts, the monopolist can charge a higher price from this segment. This finding obtained in their experiments contradicts the general notion that consumers suffer from paying a higher price than others²⁰.

If third-degree price discrimination is transferred to an input market (as modeled by Inderst and Valletti (2009)), a monopolistic supplier does not only have to decide which downstream firm should pay the lower price. It is additionally confronted with potential

¹⁹ Verboven (2002) further distinguishes between short-term and long-term elasticities in his empirical study. Most of the theoretical models abstract away from long-term effects, such as substitution with other products or new product launches as a response to low consumer demand.

²⁰ See for instance Campbell (1999a) or Xia et al. (2004).

vertical integration and the interdependence of demands for the products, increasing the complexity of the pricing decision. If the two downstream firms differ in their cost structures, the authors find that the more efficient firm pays a lower price, implying that the ex-ante differences in firm competitiveness are further augmented by the introduction of price discrimination by the supplier.

The question of which segment should receive a lower price becomes even more interesting in a competitive setting. In this case, Holmes (1989) states that the demand elasticity consists of the industry-demand elasticity (the consumer disposition whether to purchase at all) and the cross-price elasticity (the consumer disposition to switch to another seller). His model reveals that even if both firms identify the same segment as strong (or weak, respectively), the duopolists may not benefit from price discrimination if they target the “wrong” customer segment²¹. Contrarily, Chen (1997) considers the case in which firms are ex-ante symmetric and customers develop brand preferences (in the form of switching costs) after the first period, implying that firms become ex-post differentiated. Now each duopolist regards its previous customers as the “strong” market, leading to best-response asymmetry. The model shows that setting a lower price for customers of the rival firm intensifies competition and leads to inefficient switching and lower profits, while consumer surplus may be higher. A similar pattern is also suggested by Bester and Petrakis (1996), while Shaffer and Zhang (2000) show that asymmetric switching costs can induce both firms to target the same customer segment; one firm targeting its own customers and the other one targeting its potential switchers. The model of Chen et al. (2001) reveals that the duopolists might be better off if they make mistakes in identifying their own loyal customers and potential switchers, since the competition in prices is weakened.

The ability to charge different prices to different segments obviously depends on the firm’s set of information on consumer characteristics. If firms must acquire information first, Liu and Serfes (2005) show that only a high quality firm finds it profitable to do so and price discriminates (given the costs of information acquisition are sufficiently low), while a low quality seller commits to a uniform pricing schedule. Since it doesn’t have to fear strong competition from the low quality seller, the high quality firm always benefits

²¹ This result can arise when the weaker segment has a lower industry elasticity.

from more precise customer information²².

Behavior-Based Price Discrimination

In case of behavior-based price discrimination, the price a consumer needs to pay depends on his past actions. It constitutes a special form of third-degree price discrimination. Opposed to the “static” types presented before²³, this form of price discrimination introduces a temporal dimension – and is thus also referred to as “dynamic pricing”. It requires a repeated interaction between buyers and sellers and the ability of a firm to identify the buyer *and* his past behavior (Acquisti and Varian (2005)). A consumer who previously bought several DVDs might be offered a higher price for a DVD player than a consumer who purchases at the retailer for the first time, for example. Rossi et al. (1996) provide evidence that firms can indeed substantially benefit from including more information about individual purchase behavior in their pricing decisions.

Nevertheless, the behavior-based price discrimination also reveals a commitment problem: Assume the seller offers a good in the first period. The consumer’s decision whether to acquire this good reveals information about his preferences and willingness to pay. If the consumer does not buy in the first period, the seller could reduce the price in order to induce the buyer to get this product in the second period. If the seller cannot credibly commit to a price schedule *ex-ante*, the buyer adjusts his behavior (for example by delaying the purchase), hoping for a better offer in the future (Fudenberg and Villas-Boas (2006)).

In turn, consumers might have an incentive to hide their true preferences or purchase history if they otherwise fear to be faced with a higher price. In the online business, consumers deactivate cookies or create new customer accounts for example (Fudenberg and Villas-Boas (2006)). Hiding their true preferences, consumers incur various forms of costs, such as investing time to install programs or searching for new retailers offering the same good. Acquisti and Varian (2005) develop a formal model where consumers can invest in concealing their characteristics. Even if mechanisms to anonymize purchase activities are not perfect, a seller only uses information on past purchases for price discrimination if a sufficient number of consumers are myopic and the costs of hiding preferences are high

²² Precision of information is here modeled as the length of consumer sub-intervals; the smaller the intervals, the more “precise” the information.

²³ The other types of price discrimination can also be implemented if seller and buyer interact only once.

enough. Rossi et al. (1996) argue that a frequently neglected aspect in these models on behavior-based price discrimination is the cost of collecting and processing data as well as negative side-effects resulting from fairness concerns (see Chapter 2.3.5).

Coupons and Rebates

One mechanism for implementing a price discriminating strategy is to target consumers with coupons. These do not only discriminate among consumers according to their demand elasticities and individual costs of redemption but also inform consumers about products and induce trial purchases (Narasimhan (1984)). Firms can specify the coupon value (the discounts consumers get), terms and conditions of the redemption and the duration²⁴. The effect of couponing on profitability is controversial due to the costs of issuing coupons, the potential cannibalization effects and stronger competition (Neslin (1990)). Furthermore, Shor and Oliver (2006) raise the point of distortions in price discrimination based on online coupons: Consumers with lower search costs are more likely to get a discount, irrespective of their true willingness to pay.

Rebates give consumers a refund after purchasing an item. Chen et al. (2005) remark that they allow a seller to discriminate among the buyer's preferences after the purchase. The firm could even increase the price before distributing the rebates and thereby increase profits.

Overall, the past research identifies a large profit potential of price discrimination strategies. They allow firms to better customize their prices to the individual preferences of their (potential) customers. Nevertheless, the negative side-effects may not be neglected. These do not only include the costs of implementation or effects on competition, but also the reactions of consumers who observe the price differences. The following section provides a theoretical background on why consumers do not always share the firms' desire to differentiate prices.

²⁴ Krishna and Zhang (1999) show that brands that are more favored should define shorter durations.

2.3 Consumer Characteristics

2.3.1 Individual Preferences

The above-mentioned strategies aim at overcoming quality uncertainty and exploiting heterogeneity among consumers and share a common aspect: They are based on the assumption of an economic agent. Assuming an individual to be a rational and purely self-interested player, this standard in game-theoretical models has enabled the analyses of a plethora of different research questions in all areas of business and economics. The use of the same underlying assumption on individual preferences has furthermore allowed to compare the behavioral predictions of different models.

Yet experimental evidence refutes the assumption that individuals only care about their own material payoffs (Fehr and Fischbacher (2002)). If individuals' utility functions in reality deviate from those embedded in standard game-theoretical models, the actual behavior of individuals is likely to differ from that predicted by the models using standard assumptions. How do consumers react when they learn that other consumers have purchased the same good at a discount? Is it optimal to offer student discounts for the cinema when people are concerned about the prices other consumers pay or about the huge rise in profits the cinema can realize?

In standard game-theoretical models, these concerns would not matter – but intuitively, they do to consumers in the real life. The questions demonstrate that incorporating other non-economic components into the utility function of consumers has multiple implications and raises further questions on how to adequately address those issues in game-theoretical models – most of which have not yet been answered satisfactorily. *First*, how should the utility function be modified in order to be “more realistic”? As Fehr and Fischbacher (2002, p. C30) note, deviating from the assumption of economic agents might “open Pandora’s box because everything can be explained by assuming the ‘right’ preferences”. So researchers need to be careful with adjusting the utility function without the appropriate empirical and sociological support. *Second*, which implications do the changes in utility functions have on consumer behavior and, in turn, on the optimal firm strategies? Schindler (1998) shows that consumers are additionally motivated when getting a discount which cannot be explained by the price reduction itself. Some research has been conducted

on the effects of the types of preferences on pricing strategies, for example by Ackerman and Perner (2004) or Loewenstein et al. (1989). Most of the studies, however, have been based on experiments, while theoretical research lags somewhat behind to derive precise implications for different decision situations. *Third*, what would happen if the firm neglects any non-economic preferences although consumers actually care for more than just their material payoff? This question concerns the extent of the consequences from having inadequate assumptions and the precision of recommendations from theoretical models for real-life applications. Feinberg et al. (2002) show for instance that firms overestimate the profit impact of conceding a discount to new customers if customers care for more than their own material outcome.

The non-economic component of utility functions has been described by the terms “social preferences”, “other regarding preferences” or “fairness concerns” with similar meaning²⁵. In the course of the following, the term social preferences will be used. They “refer to how people rank different allocations of material payoffs to themselves and others” (Camerer and Fehr (2004, p.2)). It implies that individuals “also care positively or negatively for the material payoffs of relevant reference agents” (Fehr and Fischbacher (2002, p. C1)). Social preferences require the individual in question to take a look at others, such as other customers or the firm from which he is buying.

Displaying social preferences in one specific situation, an individual might act completely selfishly in another one²⁶. The temporal stability of social preferences could be an interesting question for psychological research, but may have a minor impact on economic theory, since most of the models concentrate on a particular decision situation and abstract away from long run developments. Several formal models have been developed that present adjusted utility functions and explain some of the deviations from the predicted behavior of standard economic agents observed in experiments (see for instance Rabin (1993) or Bolton and Ockenfels (2000)). In addition to that, it has been noted that two individuals can act very differently although being faced with the same incentives (Fehr and Schmidt (1999)). While some only pursue their own interests, others want to avoid unfair outcomes or derive

²⁵ Another stream of research focuses on the impact of social norms which are defined as “collective perceptions, among members of a population, regarding the appropriateness of different behaviors” (Krupka and Weber, 2013, p. 499). Here, individuals strive for adhering to an expected behavior, most probably leading to conformism.

²⁶ The effect of incentives on social preferences and the resulting behavior of individuals in experiments is for instance examined by Bowles and Polania-Reyes (2012).

utility from the outcomes of others, providing evidence that individuals are heterogeneous with respect to their underlying (social) preferences. The most important types of social preferences for economic theory are presented in the following.

2.3.2 Types of Social Preferences

Altruism and Envy

The first form of social preferences is altruism. It describes the unconditional and positive evaluation of resources allocated to others. Relative to other forms, this positive evaluation is not conditional on the kind or favorable actions of the other. The opposite of altruism is envy. In this case, an individual always derives a negative utility from the payoffs of others. In the model of Rotemberg (2008), altruistic individuals expect others to have similar preferences and punish others when observing less altruistic behavior. This explains common deviations from the predicted behavior in experiments. Overall, both forms of social preferences receive only weak empirical support, since they cannot explain neither the positive offers nor the numerous rejections in the ultimatum game for example²⁷ (Fehr and Schmidt (1999)).

Reciprocity

In case of reciprocity, “people are willing to reward friendly actions and to punish hostile actions although the reward or punishment causes a net reduction in the material payoff” (Fehr and Schmidt (1999, p. 2)). The definition highlights the fact that reciprocity requires some interaction between individuals compared to altruism. The second player in an ultimatum game might perceive the positive offer of the first player as unfair and therefore reject it, although this leads to a lower payoff than accepting the offer. The desire to reward or punish others can relate to the outcome or the intention of an action²⁸. Empirical evidence for reciprocity in an investment game²⁹ is given by Berg et al. (1995) who find that a majority of participants makes a positive investment, while about half of participants

²⁷ In the ultimatum game, the first player makes an offer on how to split up an endowment between the two players. If the second player rejects the offer, both get zero.

²⁸ Rabin (1993) introduces a formal model of reciprocity.

²⁹ In an investment game, the first player can invest some fraction of the initial endowment. The investment is multiplied and the second player decides on how to split up the increased amount of money between himself and the first player.

concede a positive return. The findings support the view that individuals (here: the first player) do not only trust in the benevolence of others, but that this generous behavior is also rewarded in turn (here: the second player).

Inequity Aversion

The most relevant form of social preferences for the models developed in the next sections is inequity aversion. It captures the observation that individuals prefer equitable outcomes and suffer a loss in utility if material resources are not allocated evenly. According to Fehr and Fischbacher (2002), inequity averse individuals prefer to raise the payoffs of others as long as they are below a specific level but also decrease them if they are above this threshold. Moreover, inequity aversion is self-centered (Fehr and Fischbacher (2002)) in the sense that individuals do not pay attention to general inequity between other players as long as they are not affected themselves. This poses some requirements on the availability of information and observability of outcomes. An important task for studying the role of inequity aversion therefore addresses the question of who constitutes the relevant standard of comparison – this might be for instance other agents or customers³⁰. The inequity aversion can relate to both advantageous or disadvantageous inequity aversion. In the first case, the individual is better off than others, whereas in the second case, he is worse off. Although both effects have been observed in experiments, the second effect seems to have a stronger impact on overall utility (Ho and Su (2009)).

Besides the – generally supportive – evidence of inequity aversion in experiments concentrating on standard games like the dictator game or ultimatum game³¹, inequity aversion has also been the focus of different empirical studies³². Loewenstein et al. (1989) argue that the nature of the relationship between the individual and the reference agent as well as the type of the dispute (for example a personal relationship or a business situation) influence the strength of inequity aversion. In business situations, the researchers find that individuals care more about their own material payoff and inequity aversion is less severe than in personal matters.

³⁰ In laboratory settings, the standard of comparison is more obvious than in real-life where a multitude of individuals is available.

³¹ See for instance Bellemare et al. (2008) who find that disadvantageous inequity aversion increases in the differences between payoffs.

³² Clark and Oswald (1996) find that workers are less satisfied when being faced with a higher comparison income.

In general, there is vast support for the rejection of a homogeneous population consisting of purely self-interested individuals. Indeed, the population seems to be heterogeneous and different individuals might display different social preferences – or even none. Fehr and Schmidt (1999) conclude that many of the experimental results can be explained by incorporating a fraction of individuals with social preferences. Their analysis further points out that the prevalence of individuals with different utility functions can also induce self-interested players to change their behavior. Their analysis, however, only concentrates on the most common experimental games.

This thesis takes a closer look at the theoretical implications of inequity averse consumers. For that purpose, the following section explains the inequity aversion in more detail, provides a theoretical background and relates it to the concept of price fairness. In this way, the potential consumer reactions to price discrimination strategies can be explained, highlighting the reasons for which the integration of social preferences into game-theoretical models is relevant.

2.3.3 Perceptions of Fairness

As outlined above, social preferences are widely supported by both empirical and experimental research. Individuals' aversion against inequitable outcomes regards the question of whether the individual perceives the (outcome of the) interaction as "fair". One particular area in which these fairness concerns come into play is the exchange of goods for money between a seller and a buyer. Transactors might ask themselves whether this exchange is fair in various aspects, such as friendly behavior of sales personnel, price, quality or delivery time. The utility of the transaction is in turn not only determined by the price and performance, as assumed by standard economic theory.

One of the early researchers taking on this subject is Thaler (1985) who distinguishes between the acquisition utility that is related to the material payoff and the transaction utility which captures the psychological effects of the transaction. The acquisition utility would, for example, capture the utility from purchasing a shirt of a particular quality with a particular design at a given price, whereas the transaction utility incorporates the effects from having a nice shopping experience or comparing the price with that charged for another shirt. Kahneman et al. (1986) interpret the fairness as an implicit contract between

the buyer and the seller which is enforced through the potential punishment of buyers if the seller acts unfairly. More recently, Xia et al. (2004, p. 1) describe fairness as “a judgment of whether an outcome and/or the process to reach an outcome are reasonable, acceptable, or just”. Martín-Ruiz and Rondán-Cataluña (2008) highlight that the “perceived fairness” and “perceived unfairness” as well as their impact on consumer utility can generally differ and that each of the concepts might have different influencing factors and consequences for behavior. These findings are also in line with experimental research on social preferences which finds differences between disadvantageous and advantageous inequity aversion (for example Loewenstein et al. (1989) or Fehr and Schmidt (1999)).

In general, fairness can refer to different constructs. Whereas procedural fairness refers to the way how specific results are obtained, distributive fairness relates to the result of decisions and the final allocation of resources. These two forms are theoretically supported by the principle of dual entitlement and equity theory. Interactional fairness concerns the interpersonal treatment that consumers experience in service relationships (Martín-Ruiz and Rondán-Cataluña (2008)). According to Bechwati and Morrin (2003), interactional fairness is the most important factor that influences the consumers’ decision whether to take suboptimal (that is, utility decreasing) actions³³.

The dual entitlement principle of Kahneman et al. (1986) is useful in explaining procedural fairness. It illustrates that “transactors have an entitlement to the terms of the reference transaction and firms are entitled to their reference profit” (Kahneman et al. (1986, p. 729)). From the consumers’ perspective, a seller should not improve its profit by charging a higher price, as this is perceived as an unfair exploitation to the benefit of the firm³⁴. If, however, a seller increases the price because the costs for the input factors have increased, it is perceived as less unfair. The fairness of a purchase transaction is thus assessed in terms of the reasons for the price paid. Simon and Fassnacht (2008) point out that consumers often fail to consider the role of inflation in this process. The individual assessment is thus clearly affected by the available information and bounded rationality. In a work context, the promotion of an employee is considered fair when the reasons for

³³ Their study also identifies distributional justice as key driver of the decision whether to switch to another firm but does not incorporate the role of procedural justice.

³⁴ Empirical support for the negative reactions to high profits is given by Bechwati et al. (2009).

the promotion are perceived as adequate.

According to Xia et al. (2004, p. 2), distributive justice is given when consumers “receive a reward that is proportional to what they have invested”. It can be explained with the help of equity theory. This theory goes back to Adams (1965) and states that an individual judges a transaction as unfair if “he perceives that the ratio of his outcomes to inputs and the ratio of [o]ther’s outcomes to [o]ther’s inputs are unequal” (p. 280). Comparing the ratios of inputs and outputs, inequity can be either advantageous or disadvantageous to the individual. Furthermore, it requires that both inputs and outcomes can be recognized at least by its possessor and are relevant to both parties. The inequity can result from the direct relationship of two individuals or the relationships of each individual with a third party (for example two employees comparing their wages paid by the employer with respect to the efforts made). According to the theory of cognitive dissonance, individuals experiencing such a situation feel the need to resolve the inequity (see Festinger (1962)). In order to do so, persons can change inputs, outcomes, the standard of comparison or simply leave the relationship (Adams (1965)). Distributive justice tends to have a greater impact on utility than procedural justices (Wu et al. (2012)) and it is also the focus of the theoretical models which will be derived later.

Whereas the discussion above covers the topic of perceived fairness in general, specific research has been conducted to examine the perceived fairness of a firm’s pricing decisions. Xia et al. (2004, p. 3) define price fairness as “consumer’s assessment of whether the difference (or lack of a difference) between a seller’s price and the price of a comparative other party in a transaction is equitable, reasonable or justifiable”.

Price fairness has several interesting features and influencing factors. It requires that consumers have sufficient information about others in order to compare the own price paid to that paid by others (Wu et al. (2012)). Moreover, it is evaluated from the perspective of the buyer and thus biased by his self-interest (Xia et al. (2004)), providing a rationale for why consumers feel a stronger inequity if it is at their own disadvantage. The heterogeneity among consumers can therefore also translate into differences in the evaluations of a fair or unfair price. Martín-Ruiz and Rondán-Cataluña (2008) identify the type of good and available alternatives to consumers as important influencing factors of perceived fairness.

Services, for instance, are more difficult to compare across consumers, so that unfair prices seem to evoke weaker reactions. Xia et al. (2004) further list the context of the transactions, the explanation of a pricing strategy, information about the firm's general practices and trust in the relationship as relevant influencing factors of perceived fairness.

A key concern for assessing the price fairness is the standard of comparison or, put differently, the reference point. With whom does a customer compare his own price in order to evaluate the fairness of the transaction? These specific issues are discussed in the following.

2.3.4 The Reference Point Selection

Whether a transaction is perceived as fair or unfair mainly depends on to what it is compared. Prospect theory established by Kahneman and Tversky (1979) analyzes the role of reference points in evaluating decision outcomes. The so-called value function divides the range of outcomes into those constituting a gain and those constituting a loss compared to the reference point. The shape of this value function is not the same for gains and losses: Individuals perceive losses as stronger than gains of equal size, so that the value function is steeper in the domain of losses. It is convex for losses but concave for gains – this important characteristic describes the diminishing sensitivity, as the impact of a gain or a loss decreases the further one moves away from the reference point. Since the perception of the reference point is subjective, the evaluation of outcomes is exposed to framing effects (Kahneman et al. (1986)). Depending on how a decision situation or a reference point is presented, the following judgment can differ. In the context of prospect theory, the reference point is usually the status quo (for example the initial endowment).

Nevertheless, in many cases, decision outcomes are compared to other standards. For specific products, such as food or insurances, the status quo is not the adequate reference point, as argued by Kőszegi and Rabin (2006). Following Loewenstein et al. (1989) and Guo (2012), the reference point can also be the outcome of the actions and decisions of another person. When it comes to the judgment of a transaction between a firm and a consumer, past prices, prices of competitors or those paid by other customers as well as the seller's profit constitute relevant reference points affecting individual decision making. That is why the concept of reference prices is discussed in more detail below.

Reference Prices

If an individual evaluates the fairness of a purchase transaction by comparing the current price with past or future prices, he uses reference prices as a standard of comparison. It is a multidimensional construct (Fassnacht and Mahadevan (2010)) which is affected by the individual budget, reservation prices, expected prices in the future or prices recalled from past purchases (Jacobson and Obermiller (1990)). Darke and Dahl (2003) argue that the reference price can be either internal, such as past prices, or external, for instance when a seller suggests a price for the good. Departing from the reference point, the firm conveys information to consumers (such as emphasizing an extraordinarily low price) who consequently modify their purchase behavior.

How are reference prices related to Prospect Theory? If firms announce a higher external reference price, consumers perceive the actual price for the item as a gain³⁵. Nevertheless, when consumers attribute the price reduction to the characteristics of the offered goods (the quality, for example), their evaluation of the good and their willingness to pay deteriorates (Lichtenstein et al. (1989)). The concept of reference prices also clarifies why price promotions might *lower* profits in the long run. Consumers systematically reduce their standard of comparison and therefore have a lower willingness to pay after having observed the claims of low prices (Jacobson and Obermiller (1990)). This path dependency is also emphasized by Putler (1992) who develops a formal model that incorporates both consumption and transaction utility. He provides empirical evidence on the impact of reference points, consumer loss aversion and the asymmetry of gains and losses (although the support for the last part is weak).

Firm Profit

In line with the principle of dual entitlement, consumers may also check their own payoff resulting from a transaction with that of the firm. They might regard a price as unfair if sellers make a very high profit from it. General support for fairness concerns with respect to firm profit is provided by Campbell (1999a). Wu et al. (2012) assess the consequences of consumers' inferences about the cost level of a seller after observing price discrimination

³⁵ A too high reference price might not be credible, though, as pointed out by Ackerman and Perner (2004).

and, by that, the general ability of the firm to offer a low price at all. Regardless of whether a consumer receives a lower or a higher price, he reduces the internal reference price as a consequence.

Judging the fairness of a price in terms of the profit realized by the firm requires that consumers possess information about the underlying costs and the profit level. In a formal model, Guo (2012) assumes that some consumers compare their own utility to the firm's payoff. A higher proportion of inequity averse buyers makes it more attractive for the monopolist to set a price at a "fair" level. This can signal the monopolist's true variable cost – previously unknown to consumers – and may raise their willingness to pay. In the end, the monopolist might even benefit from consumers being inequity averse.

The assumption regarding the consumers' knowledge about firm profits is cast into doubt by Englmaier et al. (2012) and Bolton et al. (2003). In their empirical study, Bechwati et al. (2009) observe that respondents tend to underestimate the costs of research and development efforts. Nevertheless, Martín-Ruiz and Rondán-Cataluña (2008) reason that even incorrect inferences of a seller's profit influence consumer utility. Fairness evaluations of prices with regard to the seller's profit are especially affected by the bounded rationality of consumers and the degree of information asymmetry. While the production costs for some products are discussed publicly (for instance clothes or smart phones), they might be less obvious for other items, such as health services. Moreover, it is unclear what a "fair" distribution of surplus would be. A more salient reference point for consumers might therefore be the utility of other consumers.

Other Consumers

Comparing the fairness of a transaction by paying attention to the realized payoffs of other customers rather than that of the seller seems to be more realistic due to the higher level of identification – an individual finds his own decision situation more similar to that of another individual than that of the seller (Englmaier et al. (2012), Xia and Monroe (2010)). The empirical study of Haws and Bearden (2006) reveals that the comparison with other consumers has also the greatest impact on the overall perceived unfairness of the transaction. If consumers buy the same good, Wu et al. (2012) argue that they also want to pay the same prices. Whether or not an individual compares himself to a particular

other customer – and the extent to which the result affects the overall utility – depends on the similarity of the two³⁶. According to Xia et al. (2004) and Wu et al. (2012), this comparison process is subject to a similarity bias: Having identified similarities with others, an individual selectively seeks information that further confirms this notion.

Observing lower prices paid by others can have two effects on consumer utility (Ackerman and Perner (2004)). First, even if consumers only learn about the prices paid by others after the purchase, they might become dissatisfied. The dissatisfaction can impact the buyer-seller relationship in the long-run. Second, learning about the prices charged to other consumers, individuals automatically adjust their internal reference price and in turn their willingness to pay. A formal model on inequity aversion between two similar agents (called followers) and between the agents and the principal (called leader) is examined by Ho and Su (2009). They play an ultimatum game, where the leader makes sequential offers to the first and the second follower, respectively, and the second follower observes a noisy signal on the first offer. Inequity can not only arise between the leader and a follower but also between the followers. By offering a low amount to the first follower, the leader can benefit from high profits in the first period and a reduced reference point of the second follower. As a consequence, a higher offer is made to the second follower.

2.3.5 Consumer Reactions to Perceived (Un)Fairness

Individuals' evaluations of a transaction are influenced both by the perceived value of the transaction and the social comparisons to others (see for example Tsai and Lee (2007)). Observing price differences, consumers adjust their cognitive and emotional judgment of the transaction (Tsai and Lee (2007)). The process of social comparison evokes either positive or negative emotions, according to Ackerman and Perner (2004). The researchers find that having paid a lower price than another person might lead to happiness, enjoyment or gratefulness. These non-financial rewards in turn influence the purchase satisfaction (Herrmann et al. (2000)) – even more strongly than the relative price reduction itself does³⁷. What happens when a consumer belongs to the segment that is granted a discount or, to put it differently, is “targeted”? In this case, Barone and Roy (2010a) and Barone

³⁶ A more complex issue arises when a consumer compares with several other (and different) consumers.

³⁷ In the context of public goods, Ajzen et al. (2000) find a positive correlation between the perceived fairness and the donations for a charity project.

and Roy (2010b) emphasize the mediating role of the consumer's attitude towards being part of the targeted segment. Only if an individual perceives it desirable to belong to this segment, he derives a higher utility from being targeted. Contrarily, Xia and Monroe (2010) find ambiguous effects of advantageous inequity, which could indicate that some consumers still perceive inequity as unfair, while others are happy to pay a comparably lower price.

Similarly, negative emotions such as regret, anger, envy or humiliation mediate the impact of perceived unfairness on customer satisfaction with the store and the good, the intention to purchase or to switch to another firm, the willingness to complain or the spread of negative word-of-mouth to others (Ackerman and Perner (2004), Xia et al. (2004)). Moreover, Bechwati and Morrin (2003) find that individuals even decide for action alternatives that do not maximize their own utility if they perceive a transaction as unfair. If a principal can offer different contracts to two asymmetric agents (and the principal receives a higher utility but to varying degrees across the contracts), Cabrales and Charness (2005) find that agents more often reject the contracts with the strongest inequity. If consumers compare their own outcome to that of other buyers, Wu et al. (2012) point out that the perceived unfairness is highest for disadvantaged consumers and depends on the type of implemented price discrimination. This finding is also supported by Rotemberg (2011) who demonstrates that the perceived unfairness is lower if third-degree price discrimination is based on differences in income rather than differences in demand elasticity. A specific focus on perceived unfairness in the online business is taken by Shor and Oliver (2006). Being asked for a coupon code before completing the purchase, consumers are informed that discounts are available and their purchase probability is reduced.

Consumer reactions to some form of perceived price unfairness (either due to a raise or differences in prices) are mediated by several factors. The provision of information and the motive of the firm play a crucial role³⁸. If consumers find out that the firm is responsible for a price increase (rather than an exogenous increase in prices of input factors), they perceive the change as less fair (Vaidyanathan and Aggarwal (2003)). Campbell (1999a) adds that the firm's reputation mediates this effect. Englmaier et al. (2012) suggest that the negative reciprocity of consumers paying the higher price is weakened when they learn that other

³⁸ This finding can be explained by attribution theory which states that individuals attempt to find a rationale for a particular event, either internally or externally (Kelley (1973)).

consumers pay a lower price due to a lower income. If a firm offers discounts to consumers, Schindler (1998) suggests that it should make the customer feel being responsible for the reduced price. This is supposed to strengthen positive feelings and thereby might increase the purchase intention or customer satisfaction.

Especially the negative reactions of consumers to perceived unfairness in transactions substantially affect their willingness to pay and purchase satisfaction. Theoretical and empirical research has disregarded the potential side effects in the past (Darke and Dahl (2003)). If firms neglect these aspects, they might suffer from lower profits in the long run – despite potential short run improvements in profitability³⁹. They do not only have to consider the potential negative effects from the behavior of the dissatisfied consumers but also the further implications, for example boycotts of consumers who have heard of, but have not experienced the unfairness themselves (Bechwati and Morrin (2003)).

2.4 Implications of Social Preferences for Firm Strategies

Past research shows that firms need to internalize the emotions of consumers caused by perceived price unfairness (Rotemberg (2011)), for instance by adjusting the price setting. Fairness concerns limit the implementation of a price discrimination strategy and can explain price rigidity in markets where consumer heterogeneity could be theoretically exploited (Rotemberg (2011) and Ho and Su (2009)). Additionally, Ho and Su (2009) argue that a firm entering markets sequentially should first sell to high value and afterwards to low value consumers if individuals care about the prices charged to others. In a competitive setting, Feinberg et al. (2002) identify betrayal (consumers are less loyal if the own firm offers discounts to new customers) and jealousy effects (consumers are less loyal when another firm offers discounts to its loyal customers) and suggest that firms should charge a lower price to their own customers.

Another example for modifications of the pricing strategy as a response to non-economic concerns is provided by Rotemberg (2011). If heterogeneity in terms of preferences is given on the seller side (so that a monopolist is either selfish, naive altruistic or sophisticated altruistic), consumers might infer the type of the firm after observing the pricing strategy.

³⁹ Anderson and Simester (2008) show that profits decrease if larger sizes in a mail-order catalog of fashion are offered at higher prices.

“Angry” consumers care about the type of firm, while “calm” consumers do not, as they only maximize their own material payoff. A naive altruistic firm assumes that all consumers are calm, whereas the sophisticated altruist and selfish type internalize the effects of angry consumers. While a selfish firm prefers to price discriminate, a naive altruist is more inclined to forego price discrimination. The sophisticated altruist finds it optimal to charge a uniform price, too, in order to appear less selfish which would induce negative consumer responses.

In addition to changing the price strategies, firms can reduce the potential negative reactions of consumers by explaining price differences or price reduction, as suggested by Englmaier et al. (2012). The provision of information facilitates the consumers’ desire to attribute the pricing strategy to specific causes (Vaidyanathan and Aggarwal (2003), Lichtenstein et al. (1989)). In this way, the firm can improve the perceived fairness without altering the pricing strategy, as pointed out by Simon and Fassnacht (2008). Moreover, since consumers compare their own transaction to other similar ones, a firm might also want to differentiate the various transactions more strongly (Xia et al. (2004)).

2.5 Evaluation of the Literature

Having discussed several distinct streams of literature using theoretical, empirical or experimental research methods, it is reasonable to briefly consider both their contributions and limitations and to identify potential gaps.

Different approaches have been taken in order to model consumer uncertainty about the true characteristics of products. Firms can use several instruments in order to signal their product quality. However, some of these models are limited in their assumptions regarding the firms’ scope of decision. While some researchers let firms make decisions about a good or bad production technology (Liebeskind and Rumelt (1989) or Allen and Faulhaber (1988)), others abstract from any strategic choices and include quality as an exogenous variable in the model (for example Gal-Or (1989), Milgrom and Roberts (1986), Hertzendorf (1993) or Bagwell and Riordan (1991)). This assumption might simplify the game theoretical analysis but leaves out a key strategic decision variable: whether a firm wants to signal its product quality is often inherently related to the *strategic* choice of a quality level.

The theoretical and empirical research on price discrimination has been illuminating and has covered various facets so far. The most relevant drivers of particular pricing strategies as well as their impact on profit have been analyzed in various contexts. Despite the evidence on the impact of perceived fairness (as pointed out in Section 2.3.3), theoretical models on price discrimination have mostly concentrated on standard economic agents and thus failed to account for emotional consumer reactions. This gap in research will be addressed by the models developed in the next sections.

Within the scope of fairness concerns, different forms of social preferences have been identified with the help of laboratory experiments. In particular, the role of perceived fairness or unfairness with respect to purchase relationships has been examined in experiments and empirical studies. Research on social preferences has already made substantial progress; however, much work needs to be done in order to strengthen the results obtained so far. The different types of preferences have been identified almost solely based on laboratory experiments. Defended by for example Falk and Heckman (2009), the experimental approach has also been criticized for several limitations (Levitt and List (2007) and Lichtenstein et al. (1989)), such as the role of social desirability or the decision context as potential drivers of individual behavior. Bardsley (2008) supports this perspective with experimental results and notes that rejections in the Dictator Game could also be “experimental artifacts”. Another limitation concerns the characteristics of participants. Most experiments have been conducted with business students. Comparing them to adults, Anderson et al. (2013) find that students exhibit less social preferences⁴⁰.

The two-period model of quality uncertainty and price discrimination with inequity averse consumers which will be developed in the next section attempts to fill the current research gap on price discrimination in three different ways. *First*, it analyzes asymmetric firms selling experience goods where product quality is not only given exogenously by nature. Instead, a low cost type may choose from a range of product qualities. *Second*, it addresses the question of whether price discrimination might serve as a quality signal in equilibrium. *Third*, it accounts for the fact that consumers paying a higher price per quality might feel disappointed and thus integrates a particular form of social preferences

⁴⁰ A similar result is obtained by Falk et al. (2013).

into a specific real-life decision context. This point is further examined by the following two models which consider the influence of disadvantageous inequity aversion on the implementation of price discrimination in duopolies. The first of these two models studies whether second-degree price discrimination constitutes a profitable strategy in order to increase the market power, while the second one analyzes the implications of social preferences on the pricing and quality decisions in the context of third-degree price discrimination. As a result, the models extend the current research by integrating a specific form of social preferences and studying their impact on optimal firm behavior – both in terms of quality and price choices.

3

Monopoly with Quality Uncertainty

3.1 Motivation

The analysis of the literature reveals that past research has not appropriately considered the role of social preferences in consumer behavior and, in turn, their impact on firm strategies. In particular, the past analyses of firms' pricing decisions have often neglected the perceived fairness or unfairness of price differences. The following two sections study the role of disadvantageous inequity aversion when different types of firms (that is, with different levels of costs) act in a market – both in a monopoly (Section 3.2) and in a duopoly (Sections 4 and 5). How does the inequity aversion affect optimal prices? Under which conditions does the firm decide to reveal the true quality of its goods? And how does the competitive pressure alter the pricing strategy as well as the resulting equilibria constellations? The monopoly model developed in this section provides answers to the first two questions and extends the current research with respect to the quality choices and pricing strategies of the monopolist as well as consumer preferences.

Many models assume that the asymmetric distribution of information between firms and consumers stems from the exogenous assignment of qualities to firms. This model incorporates the selection of product quality to the extent that one type can choose whether

to offer high or low quality or both. The variable costs of quality are exogenously given and asymmetric across firm types, giving rise to quality uncertainty, since consumers cannot observe the cost type and quality choices before the purchase decision. Examples for exogenous variable costs include differences in production technologies or worker ability. The following situation might illustrate this aspect: A firm needs a specific machine for producing its goods. This machine could be efficient in the sense that it consumes little energy. Producing a good with this machine therefore causes low costs. But the firm might also have an inefficient machine requiring more energy which leads to higher costs per unit of output produced. A second example relates to the abilities of employees. A firm with highly skilled workers produces the same output in a shorter time period than a firm with less skilled employees. If both firms pay the same hourly wage, then the firm employing better workers enjoys lower unit costs.

The second important aspect of the model – besides the quality uncertainty – relates to the opportunity of firms to exploit the heterogeneity in consumers' willingness to pay. In the model, the monopolist can price discriminate based on the qualities sold. That means that the firm can offer goods of different quality levels and charge different prices, where the price difference does not correspond to similar differences in costs. Consumers are offered the same menu of products and they can buy their most preferred option – depending on their individual tastes.

However, as outlined in the chapter before, the price discrimination might evoke negative emotions and thus modify the behavior of consumers. By introducing disadvantageous inequity aversion, the model addresses the topic of social preferences. This is done in form of a social comparison between consumer segments. As shown by theoretical and empirical research, consumers often take a look at the price paid by others. Faced with different product variants sold at different prices, customers pay attention to the differences in price-quality ratios rather than the mere difference in prices. Paying a higher price per quality unit than those buying a different product, consumers suffer a loss in utility that depends both on the size of the difference between the ratios and the strength of the social preference parameter.

The model has two periods and follows for example Liebeskind and Rumelt (1989) in assuming that the price and quality decisions are fixed over time. Even in real life

these variables are often relatively stable over time. A restaurant, for instance, usually has constant prices over months and the level of quality remains constant as well. The following game-theoretical analysis allows to study the implications of quality uncertainty on pricing strategies in the long run when consumers are inequity averse.

3.2 Introduction to the Model

3.2.1 Assumptions of the Model

Consumer Characteristics

In this model of vertical differentiation, consumers are assumed to be rational utility maximizers. The total mass of consumers is normalized to one without loss of generality. These are heterogeneous in their valuations of product quality¹. In fact, the quality preference is measured by the parameter θ which is uniformly distributed on the interval $[0, 1]^2$. Consumers with a higher θ derive a higher utility from quality and thus are willing to pay a higher price for the good than consumers with a lower realization of θ , ceteris paribus. Those individuals with a very low preference for quality will not buy at all if the price is not very small, resulting in an uncovered market. Each consumer has a maximum demand of one unit. The expected utility for a quality q and a price p is:

$$Eu = \theta q - p \tag{3.1}$$

Consumers are only heterogeneous with respect to their taste for quality, but share the same beliefs about the expected quality. They maximize their expected utility by deciding whether to buy a good – and if two goods are offered, which of the items to buy. In particular, if the firm offers both high and low quality at different prices (quality-based price discrimination), consumers need to decide to which segment they want to belong. In the following, the consumer who is indifferent between buying the expensive and the cheap good is denoted by θ^* , while the marginal consumer who still buys the cheaper good is given by θ^L , where $0 \leq \theta^L < \theta^* \leq 1$. Furthermore, *high value consumers* with $\theta \in (\theta^*, 1)$

¹ Liebeskind and Rumelt (1989) point out that the “quality” of the good can also refer to the quantity or other attributes that consumers value.

² θ can also be interpreted as the probability that a product matches the preferences of the consumer perfectly.

are referred to as those buying the more expensive good, while *low value consumers* with $\theta \in (\theta^L, \theta^*)$ are referred to as those buying the cheaper good.

A price discrimination strategy may have adverse effects on consumer utility. Individuals are assumed to display a disadvantageous inequity aversion due to the social comparison with those consumers buying the other good. Having to pay a higher price per quality than others, the expected utility of consumers is reduced. The disadvantageous inequity aversion is captured by the parameter γ , $0 \leq \gamma \leq 1$. If consumers self-select into segments, some of them decide to buy the more expensive good with quality q_h , while others enjoy the discount δ conceded for low quality q_l .

Given the assumption that consumers compare their relative price-quality ratios, two cases can occur. On the one hand, the consumers buying high quality could pay the higher relative price. On the other hand, the consumers deciding for low quality could have the higher price quality ratio. Depending on which segment pays the higher price per quality, two different utility functions can arise for each segment. As far as the first case is considered, the expected utility functions for the two consumer segments are:

$$\begin{aligned} Eu_h &= \theta q_h - p - \gamma \left(\frac{p}{q_h} - \frac{\delta p}{q_l} \right) \\ Eu_l &= \theta q_l - \delta p \end{aligned} \tag{3.2}$$

It can be seen that the expected utility of consumers buying the more expensive good consists of the acquisition utility derived from paying price p for the quality q_h and the transaction utility resulting from the comparison with the other segment³. This second part of the utility function introduces the new feature of social preferences to the framework⁴. It captures the intuition that high value consumers compare their price for the quality of their product with the price low value consumers need to pay for low quality. In turn, high value consumers suffer from the fact that low value consumers pay a lower price per quality and make a “better deal”. Note that the inverse percentage discount δ must be sufficiently small ($\delta < \frac{q_l}{q_h}$) so that the difference between price-quality ratios above is positive.

³ This distinction goes back to Thaler (1985). The two forms can also be named as “consumption utility” and “inequity disutility”.

⁴ To the author’s knowledge, this form of social preferences has not yet been incorporated by any model in past research.

The second case (where the high value customers make the “better deal” and low value customers suffer an additional loss in utility) is given whenever $\delta > \frac{q_l}{q_h}$:

$$\begin{aligned} Eu_h &= \theta q_h - p \\ Eu_l &= \theta q_l - \delta p - \gamma \left(\frac{\delta p}{q_l} - \frac{p}{q_h} \right) \end{aligned} \tag{3.3}$$

In this case, low value consumers do not only receive the lower quality but also pay a higher relative price. This would result in zero demand for the low quality good, since all consumers would then decide for the expensive good⁵. A successful price discrimination strategy thus requires that the low value segment pays a lower price per quality unit than the high value segment.

Firm Characteristics

The good is produced by a monopolist⁶ whose variable cost of quality is determined exogenously. Let *type A* be the monopolist with low costs, c_A , and *type B* the monopolist with high costs, c_B , where $0 < c_A \leq c_B \leq 1$. That is, the monopolist is either type A with low costs or type B with high costs. The probability that the monopolist has low costs is given by μ ($0 \leq \mu \leq 1$), and with a probability of $1 - \mu$, the monopolist has high costs. Cost levels are common knowledge to all consumers and types. This means that consumers observe the two cost levels (see also Allen and Faulhaber (1988)) but cannot identify ex-ante whether the monopolist has high or low costs. The variable costs of type $i = A, B$, denoted by c_i , are linear in qualities, whereas fixed costs are zero. In addition to that, let $p_{q_j}^i$ be the price for a good of quality j sold by type i . Type i 's separating profit from charging price $p_{q_j}^i$ for quality q_j over two periods is:

$$\Pi_{q_j}^i = 2 \left(p_{q_j}^i - c_i q_j \right) \left(1 - \frac{p_{q_j}^i}{q_j} \right) \tag{3.4}$$

with $i = A, B$ and $j = l, h$. For simplicity, quality can take on two exogenously given values, q_l and q_h (without loss of generality, $0 < q_l < q_h = 1$). It is further assumed that

⁵ See Appendix for a formal proof.

⁶ Section 4 examines the game in a duopoly.

type B can only sell low quality, q_l ; it is the “bad type” on the market. Type A, however, can decide whether to sell low quality (q_l), high quality (q_h) or whether to sell both, high and low quality, and price discriminate among consumers⁷. In the latter case, δ describes the inverse percentage discount for the cheaper good with $0 \leq \delta \leq 1$ (so that consumers would pay δp), resulting in a price reduction of $1 - \delta$. Additionally, it is assumed that the price discriminating monopolist can offer two goods in the first period but only the high quality good in the second one. This feature of the model reflects the intuition that offers at a reduced price (and at a reduced quality) are often used in order to attract new consumers in the first period, while selling only the high quality at later times. Consumers get free samples of small shampoo bottles at the grocery store or a limited version of a software at a low price that is only available for a few weeks in order to induce consumers to buy the full version. If A price discriminates based on qualities, the profit function is given by:

$$\Pi_{PD}^A = (p - c_A)(1 - \theta^*) + (\delta p - c_A q_l)(\theta^* - \theta^L) + (p - c_A)(1 - p) \quad (3.5)$$

The profit function consists of three parts. The first part includes the profit from selling high quality to high value consumers in the first period⁸. The second part reflects the profit from selling a low quality product at a reduced price δp to the low value segment. The third part describes the profit from selling only high quality at the regular price p in the second period to all consumers who are still willing to buy a product.

The price and quality choices are assumed to be fixed over two periods. This implies that the firm cannot change the pricing or quality strategy after consumers have made their experiences with the products. The assumption ensures that a low quality type imitating a high quality one cannot benefit from a higher willingness to pay in the short run without suffering from a loss of sales in the long run.

3.2.2 Timing of the Game

The timing of the game is as follows: At first, nature draws a cost type of the firm. With probability μ , the firm has low costs c_A and with probability $1 - \mu$, the firm faces

⁷ These assumptions imply that a monopolist that is able to produce a higher quality is also more efficient in producing low quality.

⁸ Since high quality is normalized to one, $q_H = 1$, the marginal costs reduce to c_A in this case.

high costs of quality c_B . These costs become common knowledge to the monopolist and all consumers. Note that the information asymmetry only relates to the identity of the monopolist: Consumers know the potential costs levels c_A and c_B , but do not know ex-ante which costs the monopolist actually faces – and in turn which qualities the monopolist can produce. Second, the low cost monopolist chooses a quality. Third, both types set their optimal prices. Fourth, consumers observe the price (and inverse discount) and make a purchase decision. If one good is offered, consumers decide whether or not to buy. If the firm price discriminates and offers two goods, consumers decide whether and – if yes – which good to buy. After consuming the product, they learn the true quality and infer the type of the monopolist. Given their expected utility in the second period is positive, they will buy another unit. At last, payoffs are realized. The structure of the game is illustrated in Figure 3.1.

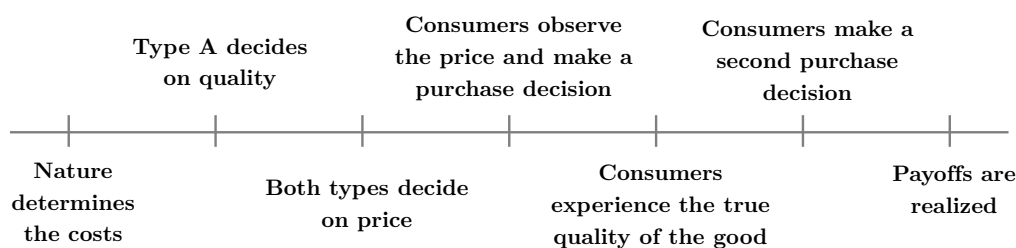


Fig. 3.1: Timing of the Game

As a result, type A decides on the quality of its goods. Both types set their optimal prices depending on the quality choice of type A. The level of costs, c_A and c_B , the social preferences γ and the level of quality q_l are parameters that are exogenously given⁹. The analysis first derives the optimal behavior under perfect information. That implies that consumers know the type of the monopolist and are therefore ex-ante certain about the quality offered. For that reason, the first-best case corresponds to a monopolist who produces a search good. In a second step, quality uncertainty is introduced and consumers can only infer the quality ex-ante if the two types separate in equilibrium. This case corresponds to a monopolist selling an experience good.

⁹ Their influence on the results is discussed in Section 3.6.

3.3 Analysis of the Model with Perfect Information

The analysis of the game under first-best assumes that there are no information asymmetries, because the exogenous assignment of cost levels is known to all consumers and types. Consumers can identify the type of the monopolist and evaluate the product quality perfectly before the purchase. By that, they are ex-ante certain about the utility derived from the transaction. The two types are not able to hide – or do not have to signal – the true quality of the goods offered. Under this assumption, only one equilibrium arises in pure strategies.

Proposition 1. *Under full information, type A sells high quality at price $p_{q_h}^A$, while type B sells low quality at price $p_{q_l}^B$.*

PROOF: SEE APPENDIX.

A low cost monopolist will always sell high quality under perfect information at price $p_{q_h}^A$ and earn $\Pi_{q_h}^A$:

$$\begin{aligned} p_{q_h}^A &= \frac{1 + c_A}{2} \\ \Pi_{q_h}^A &= \frac{(1 - c_A)^2}{2} \end{aligned} \tag{3.6}$$

The optimal price $p_{q_l}^B$ and the realized profit $\Pi_{q_l}^B$ of a high cost monopolist selling low quality are given by:

$$\begin{aligned} p_{q_l}^B &= \frac{(1 + c_B) q_l}{2} \\ \Pi_{q_l}^B &= \frac{(1 - c_B)^2 q_l}{2} \end{aligned} \tag{3.7}$$

In a first-best case, type A will only sell high quality goods and forego the opportunity to price discriminate. Given the optimal price and inverse discount chosen by A, all consumers would self-select into the high value segment, leaving zero demand for the low quality good. Moreover, it is not optimal for the low cost monopolist to sell low quality only, since this reduces the profit margin without creating additional demand. The profit maximizing option for a low cost monopolist under perfect information is to sell q_h at price $p_{q_h}^A$. B,

contrarily, can only produce low quality by assumption and maximizes its profit by setting $p = p_{q_l}^B$. Therefore, the only equilibrium under full information is one in which A sells high quality at $p = p_{q_h}^A$ and B sells low quality at $p = p_{q_l}^B$, regardless of the levels of costs c_A and c_B .

3.4 Analysis of the Model with Quality Uncertainty

The analysis of the first-best case points out that a type-A monopolist would always sell high quality, while B would only sell low quality in equilibrium, since consumers can observe the type of the monopolist before the purchase. The prices charged in this scenario, $p_{q_h}^A$ and $p_{q_l}^B$, are referred to as *full information prices*. The following analysis introduces quality uncertainty by assuming that consumers do not observe the type of the monopolist but only the general levels of costs, c_A and c_B . As a result, consumers cannot perfectly judge the product features before the purchase and only learn through their own consumption. It is further assumed that they cannot assess the utility of a good from the experiences of other consumers (implying that product quality does not become common knowledge before consumers make their second purchase decision). Instead, consumers may infer information about the product attributes through the price.

If consumers are ex-ante uncertain about quality, a high cost monopolist might want to imitate a low cost one that offers high quality. The high cost type can do this by setting the same price as the low cost type, while providing only low quality. If type A cannot effectively separate from B, both types can pool in equilibrium and consumers cannot judge the quality ex-ante: Both types act in the same way. By that, consumers rationally expect a medium quality before the purchase. While B might benefit from the relatively higher willingness to pay of consumers (compared to the case in which they anticipate low quality for sure), A could suffer from the ex-ante uncertainty of consumers. Alternatively, if the types set different prices and separate in equilibrium, consumers infer the qualities offered and uncertainty is resolved ex-ante since the price signal is perfectly informative. As a consequence, both pooling and separating equilibria might arise under quality uncertainty in pure strategies.

3.4.1 Equilibrium Concept and Equilibrium Requirements

The game under consideration features incomplete information in a dynamic context and therefore requires Perfect Bayesian Equilibria. The Harsanyi transformation (Harsanyi (1967)) allows for restructuring the game of incomplete information into one of complete, but imperfect information¹⁰. Since the firm possesses more information about its type than customers, the model describes a signaling game in which the firm chooses a price – which may or may not signal its type – and in which consumers make a purchase decision based on this price and their expectations on product quality. Both separating and pooling equilibria can exist. Figure 3.2 demonstrates which type of equilibrium can arise depending on the quality choice of type A.

B/A	q_h	q_h, q_l	q_l
q_l	Separating and Pooling	Pooling	Separating

Fig. 3.2: Overview on Quality Choices and Possible Equilibria

Before analyzing the equilibria of the game, some general remarks are in order. These concern the conditions under which an equilibrium exists as well as the further notation.

1. A pooling equilibrium can only occur if type A sells either high quality or if it introduces two goods in the first period. If both types decide to provide low quality, they are always best off by setting their respective full information prices $p_{q_h}^A$ and $p_{q_l}^B$. Since consumers know the general cost levels, they can infer that low quality is offered by either cost type and no one could benefit from setting the optimal price of the other one and pretending to have a different cost structure.
2. A low cost monopolist has never an incentive to imitate a high cost one. No matter what separating strategy considered, the type A will never pretend to have high costs of quality. It could always improve by separating with its own optimal price for low quality instead. A pooling equilibrium therefore implies that type B imitates type A.
3. If A offers both high and low quality and price discriminates, only a pooling equilibrium can exist. Even under perfect information, type A would not choose to offer

¹⁰ As a consequence, the concept of Perfect Bayesian Equilibria can be applied.

both products in equilibrium. Under quality uncertainty, the low cost type would additionally have to effectively separate from type B with the help of the pricing strategy, further decreasing the attractiveness of the strategy. For that reason, only pooling equilibria can exist when type A introduces low and high quality in the first period.

4. An equilibrium is characterized by prices $p_{q_j}^i$, discount δ (which is equal to one if only one good is offered), qualities q_j^1 and q_j^2 (when the firm does not price discriminate, the two qualities are the same, $q_j^1 = q_j^2$) and consumer beliefs that the monopolist has low costs, $\tilde{\mu}$. An equilibrium strategy is therefore described by $S = S^i(p_{q_j}^i, \delta, q_j^1, q_j^2)$. A separating equilibrium in which A charges p^* and δ^* for qualities q_j^1 and q_j^2 , while B sets p^B selling q_l and $\tilde{\mu}(p = p_{q_j}^A) = 1$ and $\tilde{\mu}(p = p_{q_l}^B) = 0$ requires that

- $p^B = p_{q_l}^B$
- $\Pi^B(p_{q_l}^B, q_l, q_l, 0) \geq \Pi^B(p^*, \delta^*, q_l, q_l, 1)$
- $\Pi^A(p^*, \delta^*, q_j^1, q_j^2, 1) \geq \Pi^A(p', \delta', q_j^1, q_j^2, 1)$ and
 $\Pi^A(p^*, \delta^*, q_j^1, q_j^2, 1) \geq \Pi^A(p^*, \delta^*, q_{-j}^1, q_{-j}^2, 1)$

These properties state that in a separating equilibrium, type B will always charge its full information price and has no incentive to imitate A, even if consumers believe that this price is defined by the low cost type A ($\tilde{\mu} = 1$). Additionally, the low cost monopolist has no incentive to deviate to a different price $p' \neq p^*$ or a different quality $q_{-j} \neq q_j$. Similarly, a pooling equilibrium requires that consumers form the belief $\tilde{\mu} = \mu$ and expect a medium quality $m = \mu + (1 - \mu)q_l$, because $q_h = 1$:

- $p^A = p^B = p^P$
- $\Pi^B(p^*, \delta^*, q_l, q_l, \mu) \geq \Pi^B(p_{q_l}^A, \delta^A, q_l, q_l, 1)$
- $\Pi^A(p^*, \delta^*, q_h, q_j^2, \mu) \geq \Pi^A(p', \delta', q_h, q_j^2, 0)$ and
 $\Pi^A(p^*, \delta^*, q_h, q_j^2, \mu) \geq \Pi^A(p_{q_l}^A, 1, q_l, q_l, 0)$

Both types charge the same price p^* in a pooling equilibrium. Given the out-of-equilibrium belief $\tilde{\mu} = 0$, neither type has an incentive to deviate from the equilibrium strategies.

In the following, the different separating and pooling equilibria are derived. A separating equilibrium can only exist if no party has an incentive to deviate from its respective strategy and consumers have consistent beliefs that type A has low costs with probability 1, while the other one is expected to have low costs with probability 0. The analysis in Section 3.4.2 identifies four separating equilibria with high (three equilibria) and low quality (one equilibrium) offered by a low cost monopolist. Similarly, a pooling equilibrium can only exist when both types set the same price, consumers observing this price form the belief $\tilde{\mu} = \mu$ and no type has an incentive to deviate and reveal the true product quality. Two pooling equilibria are identified in Section 3.4.3.

3.4.2 Separating Equilibria

Under asymmetric information, different separating equilibria might arise. On the one hand, the full information equilibrium might persist even under quality uncertainty when it is unprofitable for B to imitate the full information price of type A. On the other hand, type A might also use costly price signals in order to separate from B or decide to offer low quality as well. The conditions under which these strategies constitute separating equilibria are analyzed below.

Separating with High Quality

Proposition 2. *The strategies $S^A(p_{q_h}^A, 1, q_h, q_h)$ and $S^B(p_{q_l}^B, 1, q_l, q_l)$ and consumer beliefs $\tilde{\mu}(p = p_{q_h}^A) = 1$ and $\tilde{\mu}(p = p_{q_l}^B) = 0$ constitute a separating equilibrium if costs c_A are either sufficiently low, $c_A \in [0, c_A^*]$ or sufficiently high, $c_A \in [c_A^{**}, c_B]$.*

PROOF: SEE APPENDIX.

Under full information, the two types set the following prices $p_{q_h}^A$ and $p_{q_l}^B$ and yield the profits $\Pi_{q_h}^A$ and $\Pi_{q_l}^B$:

$$\begin{aligned} p_{q_h}^A &= \frac{1 + c_A}{2} \\ \Pi_{q_h}^A &= \frac{(1 - c_A)^2}{2} \end{aligned} \tag{3.8}$$

$$\begin{aligned} p_{q_l}^B &= \frac{(1 + c_B) q_l}{2} \\ \Pi_{q_l}^B &= \frac{(1 - c_B)^2 q_l}{2} \end{aligned} \tag{3.9}$$

For low and high costs of quality, $0 \leq c_A \leq c_A^*$ and $c_A^{**} \leq c_A \leq c_B$, the full information prices and quality choices constitute a separating equilibrium. Consumers observing these prices can perfectly infer that the monopolist charging $p_{q_h}^A$ sells high quality ($\tilde{\mu} = 1$), whereas the monopolist charging $p_{q_l}^B$ offers low quality ($\tilde{\mu} = 0$). B does not find it optimal to set the same price as the low cost monopolist ($p = p_{q_h}^A$) for these parameter ranges. When costs are too low, the relatively low price results in a very small profit margin for B, so that B is better off to reveal its true quality level. If costs are too high, only consumers with a high θ buy again in the second period after learning that the high price is paid for a low quality only. These effects diminish the attractiveness for B to imitate a high quality producer for low or high variable costs.

The full information separating equilibrium therefore exists for $0 \leq c_A \leq c_A^*$ and $c_A^{**} \leq c_A \leq c_B$, which is shaded in gray in Figure 3.3¹¹. The figure illustrates the critical values of c_A^* and c_A^{**} depending on the level of costs c_B . Since $c_A < c_B$, values above the dashed 45° line are not reasonable. In the white area, type B has an incentive to imitate the first-best price for high quality of type A, so that the first-best strategies cannot survive as an equilibrium. However, even under quality uncertainty, the full information equilibrium exists for a large range of parameters, as indicated by the gray areas.

The lower the difference between the two cost levels (or the closer a combination of costs is located to the 45° line), the more attractive it is for B to imitate the high quality supplier and the full information equilibrium cannot survive. Both critical values increase in c_B , $\frac{\partial c_A^*}{\partial c_B}, \frac{\partial c_A^{**}}{\partial c_B} > 0$. The higher the costs c_B , the higher must be the costs c_A – and consequently the full information price $p_{q_h}^A$ – in order for B to find imitation profitable.

If the full information equilibrium cannot be implemented, type A can also sell high quality and separate from type B by setting a price that B does not want to imitate. Two pricing strategies can be identified.

¹¹ In the following, reasonable parameter values are chosen to illustrate the findings. Section 3.6 analyzes the influence of parameters in detail.

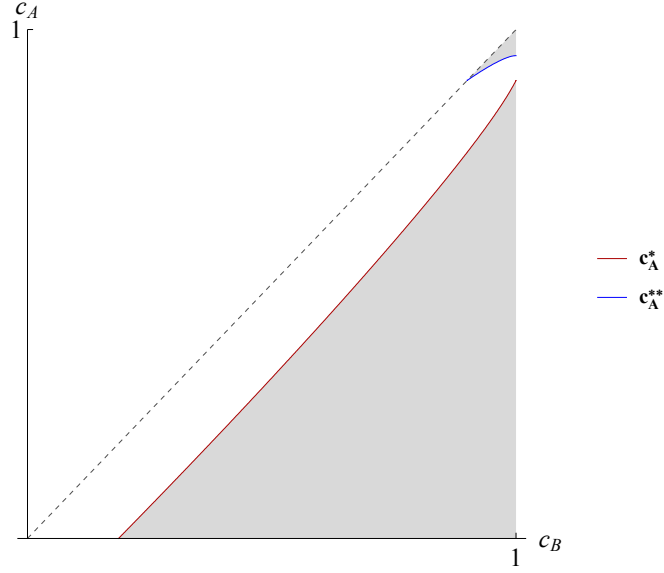


Fig. 3.3: Overview on Critical Values c_A^* and c_A^{**} for $q_l = 0.95$

Proposition 3. *The strategies $S^A(p_{S1}^A, 1, q_h, q_h)$ and $S^B(p_{q_l}^B, 1, q_l, q_l)$ and consumer beliefs $\tilde{\mu}(p = p_{S1}^A) = 1$ and $\tilde{\mu}(p = p_{q_l}^B) = 0$ constitute a separating equilibrium if costs c_A are in a lower medium range, $c_A \in [c_A^*, \min(c_A^2, c_A^c)]$. The strategies $S^A(p_{S2}^A, 1, q_h, q_h)$ and $S^B(p_{q_l}^B, 1, q_l, q_l)$ and consumer beliefs $\tilde{\mu}(p = p_{S2}^A) = 1$ and $\tilde{\mu}(p = p_{q_l}^B) = 0$ constitute a separating equilibrium if costs c_A are in a higher medium range, $c_A \in [\max(c_A^c, c_A^3), c_A^{**}]$.*

PROOF: SEE APPENDIX.

A can separate from B by charging either a low price p_{S1}^A or a high price, p_{S2}^A , resulting in the profits Π_{S1}^A and Π_{S2}^A :

$$\begin{aligned} p_{S1}^A &= \frac{1 + c_A^*}{2} \\ \Pi_{S1}^A &= 2 \left(\frac{1 + c_A^*}{2} - c_A \right) \left(1 - \frac{1 + c_A^*}{2} \right) \end{aligned} \quad (3.10)$$

$$\begin{aligned} p_{S2}^A &= \frac{1 + c_A^{**}}{2} \\ \Pi_{S2}^A &= 2 \left(\frac{1 + c_A^{**}}{2} - c_A \right) \left(1 - \frac{1 + c_A^{**}}{2} \right) \end{aligned} \quad (3.11)$$

The high cost monopolist again sets $p = p_{q_l}^B$ and earns:

$$\begin{aligned} p_{q_l}^B &= \frac{(1 + c_B) q_l}{2} \\ \Pi_{q_l}^B &= \frac{(1 - c_B)^2 q_l}{2} \end{aligned} \quad (3.12)$$

Learning about these prices, consumers correctly believe that the monopolist charging either $p_{S_1}^A$ or $p_{S_2}^A$ sells high quality ($\tilde{\mu} = 1$), whereas the monopolist with $p = p_{q_l}^B$ indeed sells only low quality ($\tilde{\mu} = 0$). For neither of the two prices ($p_{S_1}^A, p_{S_2}^A$), B has an incentive to imitate A, since A sets exactly those prices for which the high cost monopolist is indifferent between imitating A and revealing low quality. B charges its full information price in these separating equilibria again. The low cost monopolist can decide whether to signal its high quality with a high price (called *high price strategy*) or a low price (called *low price strategy*).

Under which conditions would A prefer to implement a high or a low price strategy to separate from B? For lower medium costs, $c_A^* < c_A < c_A^c$, A employs a low price strategy with $p = p_{S_1}^A$ and for $c_A^c < c_A < c_A^{**}$, A prefers a high price strategy. The optimal pricing scheme for high quality depending on the level of costs c_A is illustrated in Figure 3.4¹².

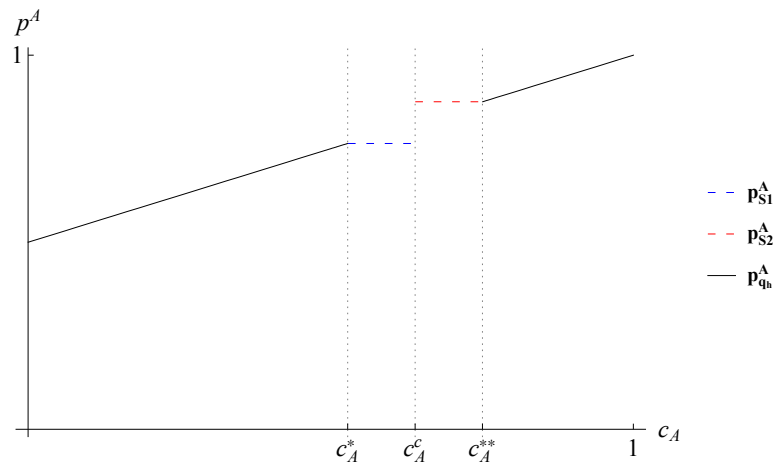


Fig. 3.4: Optimal Separating Prices for High Quality, $q_l = 0.95$ and $c_B = 0.7$

The diagram shows the level of prices for high quality the low cost monopolist optimally

¹² Note that this figure does not account for potential deviations of type A to a low quality.

implements depending on the level of costs c_A . For $c_A < c_A^*$ and $c_A > c_A^{**}$, the first best prices are chosen. Despite the higher costs $c_A > c_A^*$, A charges the same price $p_{S1}^A = \frac{1+c_A^*}{2}$ and – compared to the full information scenario – does not pass the rising costs of quality to consumers who now even benefit from the initial information asymmetry. They receive the same quality at a price that is lower than the first-best one for similar costs. For higher medium costs ($c_A^c < c_A < c_A^{**}$), A switches to a high price strategy with $p_{S2}^A = \frac{1+c_A^{**}}{2}$. Given the level of costs c_A , this price is higher than p_{qh}^A and consumers suffer a loss in their surplus compared to the first-best case.

Note that for cost levels close to c_A^* and c_A^{**} , the discrepancy to the first-best price (and thus the cost of signaling high quality) is the lowest. The impact on the profit of type A is small. So high and low price strategies are more attractive for cost levels close to the critical values c_A^* and c_A^{**} but less profitable for medium levels of costs (c_A close to c_A^c), as shown in Figure 3.5.

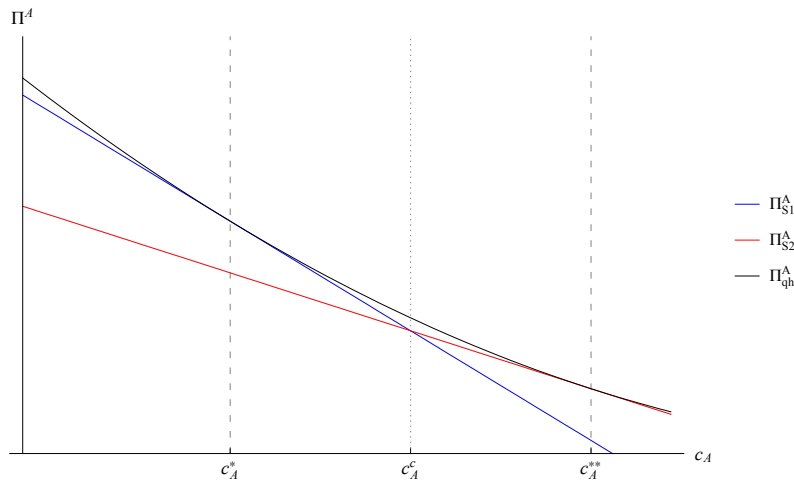


Fig. 3.5: Profit of Type A from selling q_h , $q_l = 0.95$ and $c_B = 0.7$

The separating equilibria with p_{S1}^A and p_{S2}^A , respectively, only exist if A has no incentive to deviate to p_{ql}^A and provide low quality instead. For a low price strategy with p_{S1}^A , this requires that $c_A < c_A^2$, while the high price strategy with p_{S2}^A requires $c_A > c_A^3$. That is why a separating equilibrium with $p = p_{S1}^A$ exists for $c_A \in [c_A^*, \min(c_A^2, c_A^c)]$. Similarly, the high price strategy of type A and the full information price of type B constitute an equilibrium for $c_A \in [\min(c_A^c, c_A^3), c_A^{**}]$. In Figure 3.6, the separating equilibrium with a low price strategy is highlighted in light gray, while the separating equilibrium with a high

price is represented by the dark gray area. It further shows that for medium levels of costs, neither of the two pricing strategies constitutes an equilibrium, since deviations to a low quality are sufficiently attractive for type A.

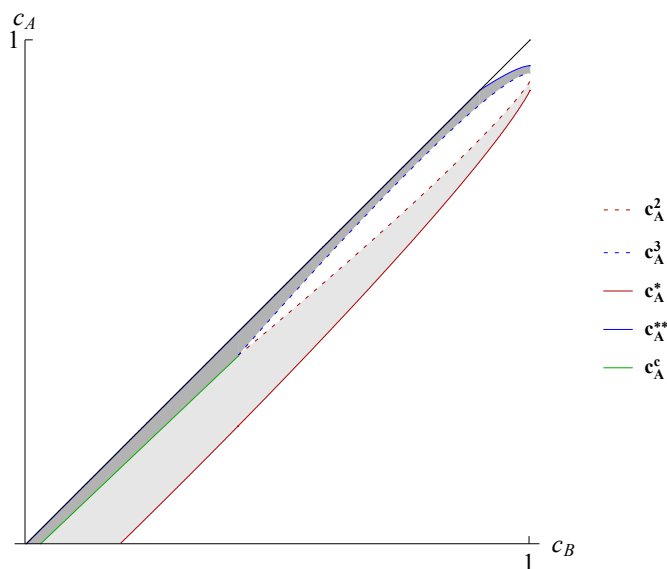


Fig. 3.6: Overview of Separating Equilibria with High and Low Prices, $q_l = 0.95$

Separating with Low Quality

If type A does not find it profitable to sell high quality and signal the product characteristics through the price, it can also decide to sell low quality at a full information price.

Proposition 4. *The strategies $S^A(p_{q_l}^A, 1, q_l, q_l)$ and $S^B(p_{q_l}^B, 1, q_l, q_l)$ and consumer beliefs $\tilde{\mu}(p = p_{q_l}^A) = 1$ and $\tilde{\mu}(p = p_{q_l}^B) = 0$ constitute a separating equilibrium for $c_A \in [c_A^2, c_A^3]$.*

PROOF: SEE APPENDIX.

If both types sell low quality goods, each will set its own optimal monopoly price. No one could gain from setting the price of the other type and the resulting profits are:

$$\begin{aligned} p_{q_l}^A &= \frac{(1 + c_A) q_l}{2} \\ \Pi_{q_l}^A &= \frac{(1 - c_A)^2 q_l}{2} \end{aligned} \tag{3.13}$$

$$\begin{aligned}
p_{q_l}^B &= \frac{(1 + c_B) q_l}{2} \\
\Pi_{q_l}^B &= \frac{(1 - c_B)^2 q_l}{2}
\end{aligned}
\tag{3.14}$$

A separating equilibrium in which both types sell low quality further requires that the low cost monopolist has no incentive to deviate to a signaling strategy and sell high quality instead. This is given for $c_A^2 < c_A < c_A^3$. Note that the condition $c_A^3 > c_A^2$ is only fulfilled for high levels of q_l : If the difference between high and low quality is sufficiently small, the low cost monopolist considers to switch to the inferior product. Otherwise, A is better off to produce high quality and signal it to consumers via a low or a high price.

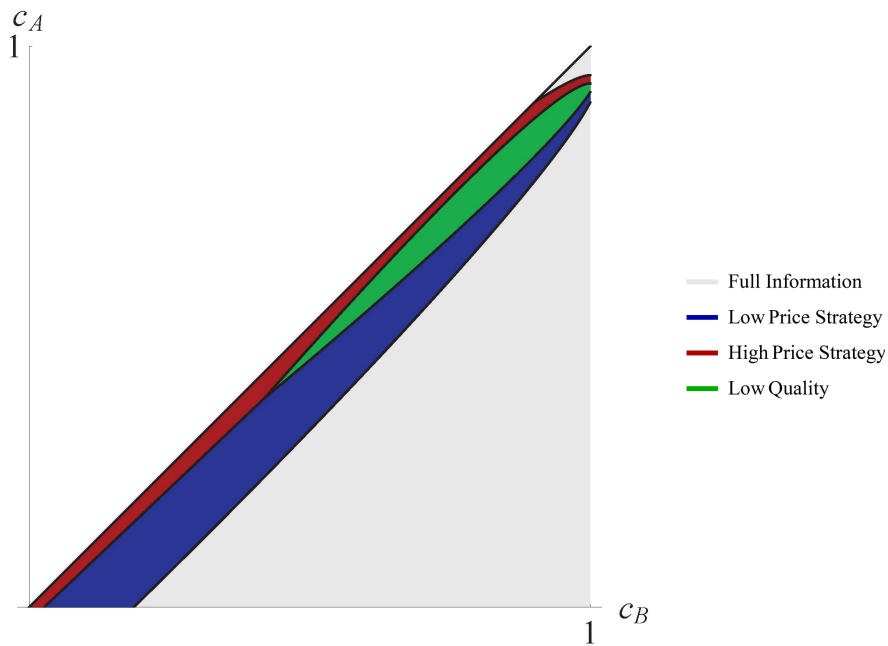


Fig. 3.7: Overview of Separating Equilibria, $q_l = 0.95$

Figure 3.7 displays the separating equilibria depending on the level of costs, c_A and c_B . It can be seen that for very low ($c_A < c_A^*$) and very high variable costs ($c_A^{**} < c_A$), the first best equilibrium is implemented even under quality uncertainty (gray area). For lower medium ranges, $c_A \in [c_A^*, \min(c_A^2, c_A^c)]$, A sells high quality at a low price p_{S1}^A (blue area). Both types offer only low quality for medium ranges, $c_A \in [c_A^2, c_A^3]$ (green area). If costs rise a bit further, $c_A \in [\max(c_A^c, c_A^3), c_A^{**}]$, then A sells high quality again at a high

price $p_{S_2}^A$ (red area). Type B always sells low quality at the full information price $p_{q_l}^B$ in these cases.

3.4.3 Pooling Equilibria

If both types set the same prices, consumers are uncertain which quality they will receive. Pooling equilibria might arise when A sells high quality or when A sells both high and low quality and price discriminates.

Pooling and Price Discrimination

In a pooling equilibrium with price discrimination, the cheap good only features low quality in any case. Consumers anticipate that low quality is provided, regardless of the cost type. However, they do not know ex-ante whether the more expensive good is worth its price (that is, whether it actually features a higher quality) and can only expect a medium quality $m = \mu + (1 - \mu)q_l$, implying that $q_l < m < 1$: With probability μ it is the low cost monopolist offering a product of high quality, while with a probability of $1 - \mu$ the monopolist has high costs and only provides low quality.

Proposition 5. *The strategies $S^A(p_{PD}, \delta_{PD}, q_h, q_l)$ and $S^B(p_{PD}, \delta_{PD}, q_l, q_l)$ and consumer beliefs $\tilde{\mu}(p = p_{PD}, \delta = \delta_{PD}) = \mu$ constitute a pooling equilibrium if costs c_A are in a medium range, $c_A \in \left[\max(c'_A, c_A^{S1**}, c_A^{B*}, c_A^*), \min(c_A^{L*}, c_A^{S2*}, c_A^{B**}, c_A^{**}) \right]$.*

PROOF: SEE APPENDIX.

If both types price discriminate, the optimal price and inverse discount are:

$$\begin{aligned} p_{PD} &= \frac{m(4mq_l(m + \gamma) + c_A(mq_l(4 + \gamma) + \gamma(3q_l - (1 - q_l)\gamma)))}{8m^2q_l + m(8q_l - \gamma)\gamma + q_l\gamma^2} \\ \delta_{PD} &= \frac{q_l(m(2q_l + c_A(5q_l - 2))\gamma + 2m^2(2(1 + c_A)q_l + \gamma) + c_A\gamma(q_l - (1 - q_l)\gamma))}{m(4mq_l(m + \gamma) + c_A(mq_l(4 + \gamma) + \gamma(3q_l - (1 - q_l)\gamma))} \end{aligned} \quad (3.15)$$

Consumers observing these prices are rational to expect a medium quality m for the expensive good, as both the low and the high cost type set the same price and discount. The profit of the low type monopolist is given by the following expressions:

$$\begin{aligned} \Pi_{PD}^A = & \frac{2q_l(m+\gamma)}{(m-q_l)(8m^2q_l+m(8q_l-\gamma)\gamma+q_l\gamma^2)} \\ & \cdot [2m^2(m-q_l) - c_A(m-q_l)(m(4-\gamma)+\gamma) \\ & + c_A^2(m^2q_l+m(1-q_l)(2-\gamma)+\gamma-q_l(1+\gamma))] \end{aligned} \quad (3.16)$$

Similarly, type B earns the following profit from imitating type A:

$$\begin{aligned} \Pi_{PD}^B = & \frac{2q_l(m+\gamma)}{(m-q_l)(8m^2q_l+m(8q_l-\gamma)\gamma+\gamma^2q_l)} \\ & \cdot [(m-q_l)(2m(m-2c_Bq_l)+c_B(m-q_l)\gamma+c_Ac_B(-\gamma+q_l(2+2m+\gamma))) \\ & - c_A^2(-q_l+m^2q_l+m(1-q_l)(2-\gamma)+(1-q_l)\gamma)] \end{aligned} \quad (3.17)$$

The price discrimination is based on a self-selection mechanism. This strategy only succeeds if consumers have incentives to purchase different products depending on their individual preferences for quality. In order to induce consumers to select different goods, the firm needs to use the price and inverse discount and create positive demands for both goods. When are the conditions of $\theta^* < 1$ and $\theta^L < \theta^*$ fulfilled? The demand for the expensive good is positive as long as $1 > \theta^*$, which translates into $c_A < c_A''$ ¹³. The low quality good is purchased when the inverse discount is sufficiently small, $\delta_{PD} < \frac{q_l}{m}$. This condition is fulfilled if costs are high enough ($c_A > c_A'$), implying a lower boundary with respect to the variable costs of quality c_A on the pooling equilibrium. As a result, price discrimination is feasible for $c_A' < c_A < c_A''$.

Consumers' belief that the monopolist has low costs is equal to the initial distribution of types, $\tilde{\mu} = \mu$, in the pooling equilibrium. The price p_{PD} and the inverse discount δ_{PD} constitute an equilibrium strategy only if no type has an incentive to deviate given the consumers' out of equilibrium beliefs of $\tilde{\mu} = 0$. The values c_A^{L*} and c_A^{B**} therefore limit the pooling equilibrium from above, because type A (type B) is better off to deviate to low quality if $c_A > c_A^{L*}$ ($c_A > c_A^{B**}$ or $c_A < c_A^{B*}$). Excluding further implausible equilibria requires the application of the Intuitive Criterion (Cho and Kreps (1987)). For lower or

¹³ This condition is dominated by the requirement of $c_A < c_A^{L*}$ as $c_A^{L*} < c_A''$. See Appendix.

higher levels of costs, $c_A < c_A^{S1**}$ and $c_A > c_A^{S2*}$, the off-equilibrium beliefs are inconsistent because only A has an incentive to deviate and the pooling equilibrium cannot survive. This puts boundaries on the right (via c_A^{S1**}) and on the left (via c_A^{S2*}) on the existence of the equilibrium, leaving price discrimination as a pooling equilibrium (orange area) for a medium range of costs, as depicted in Figure 3.8¹⁴. This finding is in line with the observation above; namely that separating with a high or low price strategy and providing high quality becomes less profitable for medium levels of costs.

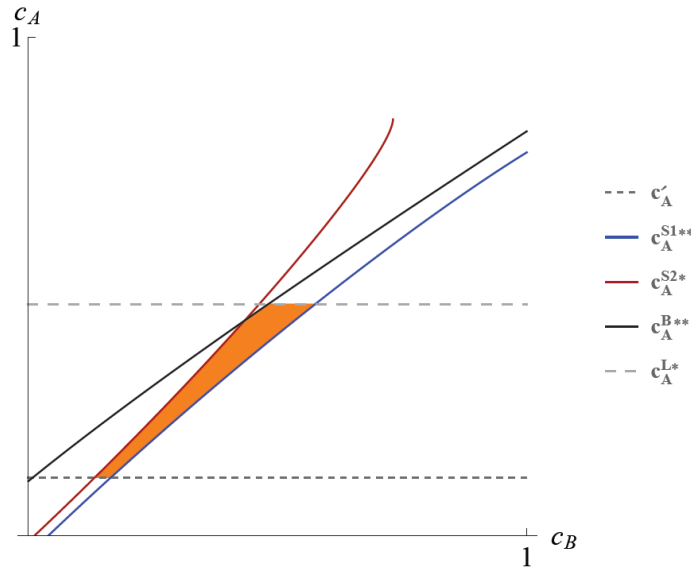


Fig. 3.8: Pooling Equilibrium with Price Discrimination, $m = 0.98$, $q_l = 0.95$ and $\gamma = 0.2$

Pooling and Uniform Pricing

A pooling equilibrium can also exist if A sells high quality, while B sells low quality.

Proposition 6. *The strategies $S^A(p_P, 1, q_h, q_h)$ and $S^B(p_P, 1, q_l, q_l)$ and consumer belief $\tilde{\mu}(p = p_P, \cdot) = \mu$ constitute a pooling equilibrium if costs c_A are in a medium range, $c_A \in [\max(c_A^{B'}, c_A^{S1''}), \min(c_A^{L'}, c_A^{B''}, c_A^{S2'})]$.*

PROOF: SEE APPENDIX.

If both types pool in prices and A sells high quality, the low cost monopolist anticipates the fall in demand due to the quality uncertainty. The optimal pooling price and the

¹⁴ Note that the critical value c_A^{B**} is negative for the chosen parameter values.

corresponding profits are¹⁵:

$$\begin{aligned}
 p_P &= \frac{m + c_A}{2} \\
 \Pi_P^A &= \frac{(m - c_A)^2}{2m} \\
 \Pi_P^B &= (p - c_B q_l) \left(1 - \frac{p}{m} + 1 - \frac{p}{q_l} \right) \\
 &= \frac{(m + c_A - 2c_B q_l)(m(3q_l - m) - c_A(m + q_l))}{4mq_l}
 \end{aligned} \tag{3.18}$$

Consumer uncertainty about product characteristics is reflected in the price which approaches the full information price for higher levels of μ . If consumers observe the price in equilibrium, their belief that the monopolist has low costs equals the initial probability, $\tilde{\mu} = \mu$. Given the out-of-equilibrium belief $\tilde{\mu} = 0$, A and B do not find it profitable to deviate for $c_A < c_A^{L'}$ and $c_A^{B'} < c_A < c_A^{B''}$, respectively. Similar to the pooling equilibrium with price discrimination, the Intuitive Criterion excludes implausible equilibrium constellations for $c_A^{S1'} < c_A < c_A^{S1''}$ and $c_A^{S2'} < c_A < c_A^{S2''}$. In these intervals, the equilibrium is implausible, because only type A has an incentive to deviate to a low or high price strategy. The pooling equilibrium under uniform pricing is represented by the brown area in Figure 3.9¹⁶.

3.5 Summary of Results

In this game of price signaling and quality uncertainty, different separating and pooling equilibria emerge, depending on the level of costs c_A (see Figure 3.10¹⁷). For very low and very high costs, the types separate and A sells high quality at p_{qh}^A , while B sells low quality at p_{ql}^B (gray area). This equilibrium is the same as the one obtained under perfect information. B cannot profitably set the same price as A and pretend to be a high quality producer, because costs are too low ($c_A < c_A^*$) or too high ($c_A > c_A^{**}$). Therefore, the high cost monopolist reveals its low quality from early on in these intervals, while the low cost monopolist can charge the full information price for its high quality good.

¹⁵ B makes a positive profit for $c_B \leq \frac{c_A + m}{2q_l}$ and $c_A \leq \frac{m(3q_l - m)}{m + q_l}$.

¹⁶ Note that the critical value $c_A^{B'}$ is negative for the chosen parameter values.

¹⁷ For illustrative purpose, the figure does not incorporate all critical values but only depicts the final equilibrium constellation.

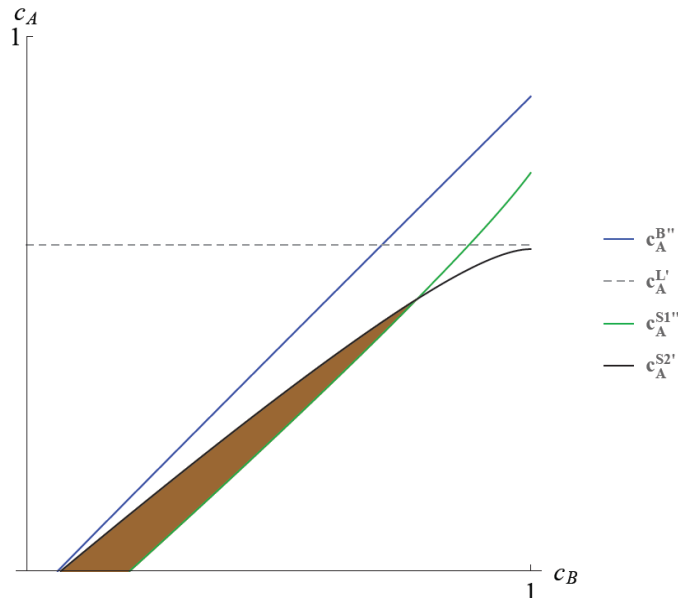


Fig. 3.9: Pooling Equilibrium with Uniform Pricing, $m = 0.95$ and $q_l = 0.8$

If, however, costs are in a medium range ($c_A^* < c_A < c_A^{**}$), the high cost monopolist would be better off to imitate the full information price of A and benefit in the short run from an increased willingness to pay. In this situation, A can effectively separate by setting either a low price p_{S1}^A (blue area) or a high price p_{S2}^A (red area). The low price strategy makes consumers better off than under the full information case, since the monopolist does not pass on the rising costs to consumers. Similarly, the high price strategy reduces consumer utility compared to the full information scenario. In both cases, nevertheless, the high cost monopolist has no incentive to imitate this price so that consumers correctly infer a high quality from observing either p_{S1}^A or p_{S2}^A before the purchase.

A separating equilibrium in which both types sell low quality exists only for a small area, $c_A^2 < c_A < c_A^3$ (shaded in green). In this case, A charges $p_{q_l}^A$ while B charges $p_{q_l}^B$. Note, however, that this equilibrium only survives if q_l is sufficiently large. Otherwise, A has always an incentive to sell high quality instead¹⁸.

Pooling equilibria can only exist if A sells high quality or if A offers both high and low quality. The first strategy is not illustrated in Figure 3.10, since it does not constitute an equilibrium for the chosen parameter values. The second strategy is a quality-based price discrimination (orange area). In this case, the equilibrium is not only constrained by a

¹⁸ See Section 3.6.1 for a more detailed discussion on the influence of q_l .

lower limit of c_A in order to induce positive demands for both segments (c'_A). Attractive deviations to low quality further exert an upper limit on the existence of the pooling equilibrium (c_A^{L*} and c_A^{B**}), while implausible equilibrium constellations are removed by left (c_A^{S2*}) and right boundaries (c_A^{S1**}).

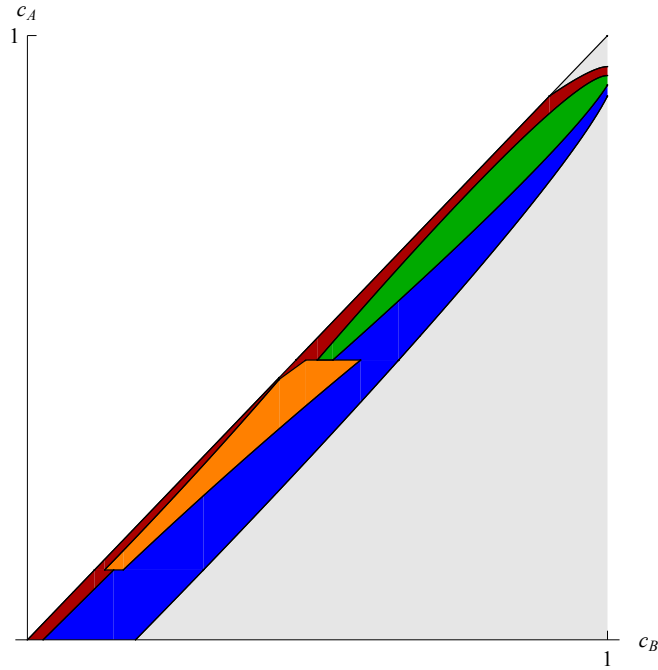


Fig. 3.10: Overview of Equilibria, $m = 0.98$, $q_l = 0.95$ and $\gamma = 0.2$

3.6 Comparative Analysis

Having derived the conditions for separating and pooling equilibria under quality uncertainty, it is now useful to take a look at how the optimal prices and profits change with specific parameters. In particular, this section examines the influences of the (expected) quality levels, q_l and m , and the social preferences in the case of price discrimination, γ .

3.6.1 Influence of the Level of Quality

The model assumes that product quality is simplified to two potential levels q_h and q_l which are exogenously defined. The level of low quality q_l as well as the initial probability that a monopolist has low costs, μ , (and therefore is able to produce high quality) significantly

influence the equilibrium constellation. The separating equilibrium with low quality and the pooling equilibrium with price discrimination only exist if q_l is high enough, whereas the second one further requires that m is sufficiently large as well, as explained in more detail below.

Influence of q_l on the Low Quality Equilibrium

The separating equilibrium in which even type A decides to offer low quality exists if the reduction in quality (from q_h to q_l) is not too severe. The lower the quality q_l , the lower the willingness to pay of consumers and the lower the profits of both types:

$$\frac{\partial \Pi_{q_l}^i}{\partial q_l} > 0 \quad (3.19)$$

The value of q_l can be interpreted as the *relative* quality compared to the high quality $q_h = 1$. That is, the lower q_l , the stronger is the deviation from high quality and the more intense the differentiation of the two goods. A reduction in q_l thus makes it more attractive for A to sell high quality, while a higher level of q_l raises the chances of a low quality equilibrium.

As a matter of fact, the separating equilibrium in which both types offer low quality can only exist if type A does not find it more attractive to sell high quality at a low or high signaling price. For lower values of q_l , A can improve its profit by offering high quality at p_{S1}^A or p_{S2}^A , because consumers have a higher willingness to pay for the product featuring a better quality. The key condition for the separating equilibrium with low quality is therefore $c_A^2 < c_A < c_A^3$. However, for most parameter values of c_B and q_l , it holds that $c_A^2 > c_A^3$, which implies that A finds it more profitable to separate with high quality either at a low or at a high price rather than providing q_l . Only if c_B is in a medium range, $c_B' < c_B < c_B''$, the condition $c_A^2 < c_A^3$ is fulfilled:

$$\begin{aligned}
c_B' &= \frac{2q_l(1+q_l) - \sqrt{2}\sqrt{q_l^2(1+q_l)(-2+q_l^2(2+q_l))}}{q_l^2(1+q_l)(2+q_l)} \\
c_B'' &= \frac{2q_l(1+q_l) + \sqrt{2}\sqrt{q_l^2(1+q_l)(-2+q_l^2(2+q_l))}}{q_l^2(1+q_l)(2+q_l)}
\end{aligned} \tag{3.20}$$

Figure 3.11 illustrates for which combinations of q_l and c_B the condition $c_A^2 < c_A^3$ holds, as indicated by the gray area.

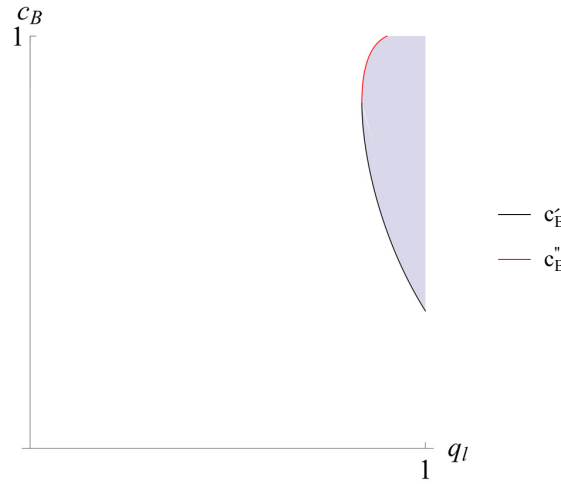


Fig. 3.11: Difference of Critical Values c_A^2 and c_A^3

The gray area in which a separating equilibrium with low quality can survive is not only small, it also requires high values of both variable costs c_B and quality q_l . The intuition for this requirement is as follows: A higher level of q_l increases A's profit from selling low quality and the discrepancy to selling high quality becomes smaller¹⁹. For that reason, the curve of $\Pi_{q_l}^A$ moves upwards closer to curve of $\Pi_{q_h}^A$, as illustrated in Figure 3.12.

The second parameter that influences the existence of the low quality equilibrium is the level of costs, c_B . Figure 3.12 also provides a rationale for why high costs c_B enable the equilibrium: The higher the costs of B, the higher the critical values of c_A^* and c_A^{**} , resulting in a shift to the right of the two dashed lines in Figure 3.12. This shift additionally leads to $\Pi_{q_l}^A$ approaching $\Pi_{q_h}^A$ in the interval (c_A^*, c_A^{**}) , increasing its attractiveness.

¹⁹ For $q_l = 1$, $\Pi_{q_h}^A = \Pi_{q_l}^A$.

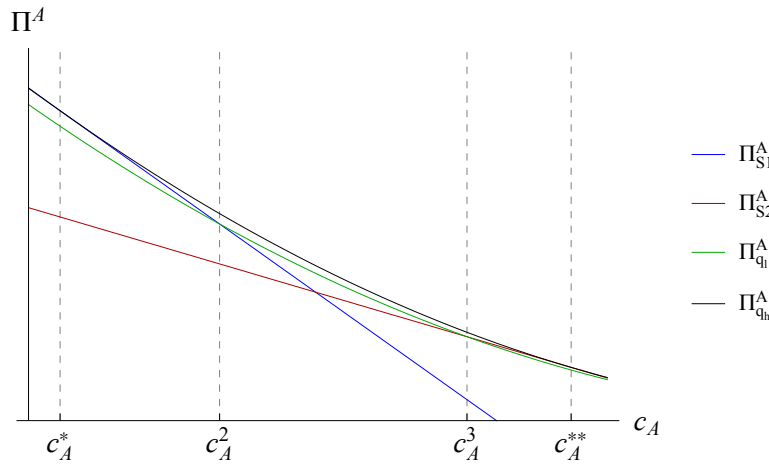


Fig. 3.12: Comparison of Separating Profits of Type A

Influence of q_l on the High Quality Equilibria

Despite the fact that an equilibrium in which both types serve low quality becomes less likely, the lower level of the quality q_l has further advantages from the consumers' perspective. The level of q_l has an impact on the prices p_{S1}^A and p_{S2}^A which type A sets in order to separate from a low quality provider. Both prices increase in q_l :

$$\begin{aligned} \frac{\partial p_{S1}^A}{\partial q_l} &> 0 \\ \frac{\partial p_{S2}^A}{\partial q_l} &> 0 \quad \forall c_A^* < c_A < c_A^{**} \end{aligned} \quad (3.21)$$

Why does a lower quality level reduce both signaling prices? The lower q_l , the more attractive it is for B to imitate the full information price of A²⁰. In order to counteract the potential mimicry, A sets a lower signaling price. That is, the lower the level of q_l , the lower the prices consumers must pay in order to receive a *high* quality item from A (if $c_A^* < c_A < c_A^{**}$)²¹. In this way, consumers might actually benefit from a lower q_l if they buy high quality from type A at p_{S1}^A or p_{S2}^A .

A higher level of q_l raises the prices p_{S1}^A and p_{S2}^A (and by that the profit margin) but at

²⁰ This holds for $c_B < \frac{(1+c_A)^2}{2(3-c_A)q_l^2}$.

²¹ For $c_A < c_A^*$ and $c_A > c_A^{**}$, A can still charge the full information price p_{qh}^A which is not affected by the level of low quality.

the same time reduces the consumer demand, as the price change does not reflect a change in the quality received. Which of the two effects dominates can be shown by analyzing the overall effect of q_l on the profits Π_{S1}^A and Π_{S2}^A :

$$\begin{aligned} \frac{\partial \Pi_{S1}^A}{\partial q_l} &> 0 \\ \frac{\partial \Pi_{S2}^A}{\partial q_l} &< 0 \quad \forall c_B > \frac{q_l^2 - \sqrt{2}(2 - q_l - q_l^2)}{2 - q_l^2} \end{aligned} \quad (3.22)$$

The low price strategy is always more profitable for higher levels of q_l . The reverse holds for the high price strategy with sufficiently high levels of costs c_B . Whereas consumers benefit from a lower level of q_l if the monopolist has low costs through the lower prices p_{S1}^A and p_{S2}^A , type A only does so for the high price strategy (that is, for $c_A \in [\min(c_A^3, c_A^c), c_A^{**}]$) when c_B is large enough.

Influence of q_l and m on the Pooling Equilibrium with Price Discrimination

The second equilibrium that is strongly driven by the value of low quality q_l is the pooling equilibrium in which A offers two goods and price discriminates. In addition to the influence of q_l , it is further affected by the initial probability that the monopolist has low costs, μ . While the effects of q_l and μ on the optimal inverse discount δ_{PD} are ambiguous, the influence on the optimal price p can be clearly determined:

$$\begin{aligned} \frac{\partial p}{\partial m} &= \frac{q_l}{(8m^2q_l + m(8q_l - \gamma)\gamma + q_l\gamma^2)^2} \cdot [32m^4q_l + 8m^2(c_A + 8m)q_l\gamma \\ &\quad - (1 - q_l)c_A\gamma^4 + (-4 + c_A)m^2 + 3c_Aq_l + 2(4 + c_A)mq_l)\gamma^3 \\ &\quad + 4m(c_A(m + 2q_l) + m(-2m + 11q_l))\gamma^2] > 0 \\ \frac{\partial p}{\partial q_l} &= - \frac{m\gamma^2(m + \gamma)(4m(m - c_A) - c_A(1 - m)\gamma)}{(8m^2q_l + m(8q_l - \gamma)\gamma + q_l\gamma^2)^2} < 0 \quad \forall c_A < c_A'' \end{aligned} \quad (3.23)$$

A higher value of m increases consumers' willingness to pay and thus the price p . Contrarily, the higher the value of low quality, the lower the price p for the high quality good due to the potential cannibalization.

More specifically, only if both – the value of low quality and the expected quality

$m = \mu + (1 - \mu)q_l$ – are sufficiently large, the low cost monopolist has an incentive to introduce two goods and pool with B. If, contrarily, the two variables take lower values, the pooling equilibrium no longer survives. This is so because A has an incentive to deviate to a low or high price signaling strategy and gain from the higher willingness to pay of consumers, making the pooling equilibrium implausible. Figure 3.13 shows the overview of equilibria for lower levels of q_l and m .

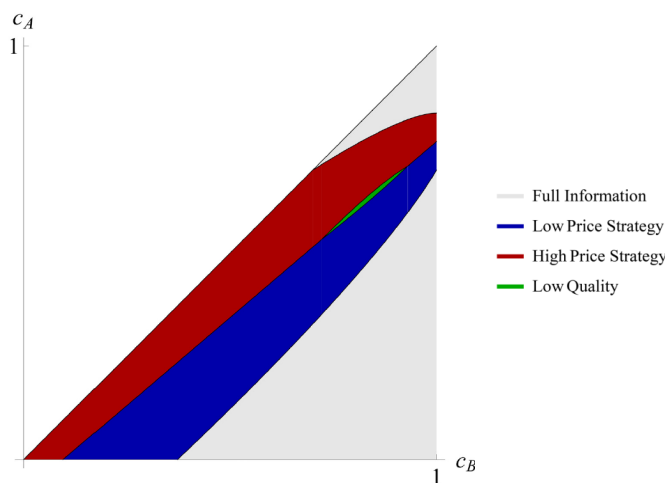


Fig. 3.13: Overview of Equilibria, $m = 0.9$, $q_l = 0.85$ and $\gamma = 0.2$

The figure does not only illustrate that the pooling equilibrium with price discrimination no longer exists, but at the same time highlights that low values of q_l also make the separating equilibrium with low quality very unattractive for A due to the lower willingness to pay of consumers. As a result, for low values of q_l and m , the low cost monopolist always sells high quality – either at the full information price or at one of the signaling prices p_{S1}^A and p_{S2}^A .

Taking the influence of q_l and m on the two equilibria into consideration, consumers can benefit from lower levels of both variables if the monopolist has low costs in so far as it removes the ex-ante uncertainty about product quality for all potential cost parameters. While B will always reveal its low quality, A signals the high quality of its products with either a high or a low price. By that, consumers can perfectly infer the true characteristics of the goods offered before the purchase if m and q_l are sufficiently low. Additionally, the lower level of q_l decreases the prices p_{S1}^A and p_{S2}^A , so that consumers pay relatively lower prices for high quality goods in the interval $c_A^* < c_A < c_A^{**}$.

3.6.2 Influence of Social Preferences

Social preferences determine the utility of consumers and in turn the optimal behavior of the low cost monopolist when introducing two goods. In fact, the parameter γ is an important driver of the pooling equilibrium with price discrimination derived in Section 3.4.3. The following section analyzes the influence of social preferences on consumer demand, prices and profits. It considers the specific cases when consumers are only self-interested and do not care about differences in the price-quality ratios ($\gamma = 0$) or strongly inequity averse ($\gamma = 1$).

Influence of Social Preferences on Consumer Demand

A change in the role of social preferences directly affects the relative sizes of consumer segments and indirectly alters the total number of consumers who purchase a good. While the marginal consumer θ^* (who is indifferent between buying the expensive and the cheap good) is immediately influenced by γ , the marginal consumer θ^L (who is indifferent between buying the cheap good and not buying at all) is not directly affected²². For the isolated analysis of the influence of social preferences on demand, other variables such as p and δ are held fixed at this point, while the interactive effects are discussed later.

When consumers of the high value segment care more about their relative price-quality ratio (that implies an increase in γ), more consumers decide for a low quality good. This finding is intuitive: The more consumers of the high value segment suffer from paying a higher price per quality, the more attractive it is for them to switch to the cheaper good. If consumers do not receive a disutility from paying a higher price per quality than others ($\gamma = 0$), the marginal consumer who is indifferent between buying the expensive or the cheap good is given by the ratio of price difference to (expected) quality difference:

$$\theta^*|_{\gamma=0} = \frac{p(1-\delta)}{m-q_l} \quad (3.24)$$

In the other extreme case, where the transaction utility from the social comparison has an equally strong effect as the acquisition utility from buying a particular quality at a given price ($\gamma = 1$), the marginal consumer is located at:

²² An indirect effect of social preferences is exerted through p and δ .

$$\theta^*|_{\gamma=1} = \frac{p(mq_l(1-\delta) + q_l - \delta m)}{mq_l(m - q_l)} \quad (3.25)$$

The marginal consumer who still buys low quality remains the same in both cases (when holding p and δ fixed). As a result, there is a fraction of consumers whose quality preferences are sufficiently high so that a rise in social preferences does not affect their decision to buy the expensive good. Contrarily, some consumers with a low preference for quality will always buy the cheaper item, no matter how weak their social preferences will be. In between, a mass of consumers whose decision which product to buy depends on the strength of social preferences.

Note that it is not yet clear whether the location of the marginal consumer θ^* increases or decreases with a rise in social preferences: The parameter γ does not only directly influence the position of the marginal consumer θ^* but also affects the optimal price and inverse discount. Whether stronger social preferences lead to lower demand for the more expensive good thus depends on their interactive effects on θ^* , θ^L and on the price p and inverse discount δ .

Influence of Social Preferences on Price and Inverse Discount

In order to study the effect of social preferences on prices, the two extreme cases of purely selfish ($\gamma = 0$) and strongly socially concerned ($\gamma = 1$) consumers will be compared. If consumers display no inequity aversion at all, the optimal price and inverse discount are reduced to:

$$\begin{aligned} p_{PD}|_{\gamma=0} &= \frac{m + c_A}{2} \\ \delta_{PD}|_{\gamma=0} &= \frac{(1 + c_A) q_l}{m + c_A} \end{aligned} \quad (3.26)$$

The high value segment then pays the optimal price under uniform pricing and pooling, while the low value segment effectively pays the optimal price for low quality under full information ($\delta_{PD} p_{PD} = p_{q_l}^A$).

Contrarily, if consumers exhibit very strong social preferences, $\gamma = 1$, the optimal price and inverse discount are:

$$\begin{aligned}
p_{PD}|_{\gamma=1} &= \frac{m(4m(1+m)q_l + c_A(-1 + (4+5m)q_l))}{q_l + m(-1 + 8(1+m)q_l)} \\
\delta_{PD}|_{\gamma=1} &= \frac{q_l(2m(m+q_l+2mq_l) - c_A(1+2m - (2+m(5+4m))q_l))}{m(4m(1+m)q_l + c_A(-1 + (4+5m)q_l))}
\end{aligned} \tag{3.27}$$

Comparing the two optimal prices, it can be shown that the price for purely selfish agents is higher than that for socially concerned ones (this holds whenever price discrimination is feasible for $\gamma = 1$,²³ that is, $c_A > c'_A|_{\gamma=1}$):

$$\begin{aligned}
\Delta_p &= p_{PD}|_{\gamma=0} - p_{PD}|_{\gamma=1} \\
&= \frac{c_A(q_l + m(1 - 2mq_l)) - m(m - q_l)}{2(q_l + m(-1 + 8(1+m)q_l))} > 0
\end{aligned} \tag{3.28}$$

Strong social preferences induce the low cost monopolist to reduce the price charged to consumers of the high value segment. This finding is intuitive, since the monopolist needs to counteract the decreasing willingness to pay of the high value segment resulting from the stronger concern for the price-quality ratio of the low value segment. How do the social preferences influence the optimal inverse discount δ_{PD} ?

$$\begin{aligned}
\Delta_{\delta_{PD}} &= \delta_{PD}|_{\gamma=0} - \delta_{PD}|_{\gamma=1} \\
&= -\frac{q_l(2m^2(m - q_l) - c_A^2(1+m)(1 - (2-m)q_l))}{m(m + c_A)(4m(1+m)q_l + c_A(-1 + (4+5m)q_l))} < 0 \quad \forall c_A < c''_A|_{\gamma=1}
\end{aligned} \tag{3.29}$$

The difference is negative for the interval $0 < c_A < \frac{\sqrt{2}\sqrt{m^2(m-q_l)}}{\sqrt{1+m-2q_l-mq_l+m^2q_l}}$. Since $c''_A|_{\gamma=1} < \frac{\sqrt{2}\sqrt{m^2(m-q_l)}}{\sqrt{q+m-2q_l-mq_l+m^2q_l}}$, the value of δ_{PD} is higher for strong social preferences, $\delta_{PD}|_{\gamma=0} < \delta_{PD}|_{\gamma=1}$. An increase in social preferences therefore does not only lower the price but it also raises the inverse discount in order to balance the cannibalization effects. Strong social concerns in the high value segment consequently also impose an effect on the utility of the low value segment. The effective price for the low quality good ($\delta_{PD}p_{PD}$) is *higher* under full preferences:

²³ Equations 3.35 and 3.36 will show why the critical values of $c'_A|_{\gamma=1}$ and $c''_A|_{\gamma=1}$ are relevant for this analysis.

$$\begin{aligned}
\Delta_{\delta PDPPD} &= \delta_{PDPPD}|_{\gamma=0} - \delta_{PDPPD}|_{\gamma=1} \\
&= \frac{q_l (c_A (2 + m (3 - 2q_l) - 3q_l) - (1 + 4m) (m - q_l))}{2 (q_l + m (-1 + 8 (1 + m) q_l))} < 0 \quad \forall c_A < c_A''|_{\gamma=1}
\end{aligned} \tag{3.30}$$

That implies that the low cost monopolist responds to strong social preferences by lowering the price for high quality and raising the effective price for low quality. The difference in prices is thus reduced for strong social preferences.

Interactive Effects of Social Preferences on Consumer Demand

Having examined the effects of high social preferences on the optimal inverse discount and price, it is now interesting to see how the marginal consumers θ^L and θ^* change in turn. The total number of consumers who buy is given by $1 - \theta^L$. It can be shown that the marginal consumer θ^L is located higher if social preferences are strong:

$$\begin{aligned}
\Delta_{\theta^L} &= \theta^L|_{\gamma=0} - \theta^L|_{\gamma=1} \\
&= -\frac{(1 + 4m) (m - q_l) - c_A (2 - 3q_l + m (3 - 2q_l))}{2 (q_l + m (-1 + 8 (1 + m) q_l))} < 0
\end{aligned} \tag{3.31}$$

This holds for the range of $c_A'|_{\gamma=1} < c_A < c_A''|_{\gamma=1}$. How does the parameter γ affect the location of θ^* ? On the one hand, the rise in γ shifts θ^* upwards, ceteris paribus. On the other hand, the decrease in p and the increase in δ make the low quality good relatively less attractive which shifts θ^* downwards. The overall effect of a rise in γ from 0 to 1 on the marginal consumer is:

$$\begin{aligned}
\Delta_{\theta^*} &= \theta^*|_{\gamma=0} - \theta^*|_{\gamma=1} \\
&= \frac{(m - q_l) (q_l + m (3 + 4q_l)) - c_A (-6m^2q_l + (5 - 3q_l) q_l + m (3 + (3 - 2q_l) q_l))}{2 (m - q_l) (q_l + m (-1 + 8 (1 + m) q_l))}
\end{aligned} \tag{3.32}$$

For sufficiently large costs, $c_A > c_A^\gamma$, the total effect of stronger social preferences on the marginal consumer is positive, $\theta^*|_{\gamma=0} < \theta^*|_{\gamma=1}$.

$$c_A^\gamma = \frac{(m - q_l)(q_l + m(3 + 4q_l))}{-6m^2q_l + q_l(5 - 3q_l) + m(3 + q_l(3 - 2q_l))} \quad (3.33)$$

For small costs, however, the influence of the parameter γ is weaker than that of the changes in price and inverse discount, so that $\theta^*|_{\gamma=0} > \theta^*|_{\gamma=1}$. This implies that for small costs, $c_A < c_A^\gamma$, strong concerns for the price-quality ratio of others can even lead to *more* consumers deciding to buy the more expensive item due to the price reduction for the expensive product and the price increase for the cheaper one.

The location of the marginal consumer θ^* further influences whether the demand for low quality is positive at all. Given the optimal price and inverse discount, consumers have an incentive to buy the low quality good ($\theta^* > \theta^L$) if the inverse discount δ is sufficiently small ($\delta < \frac{q_l}{m}$). This condition is fulfilled if costs are sufficiently large ($c_A > c'_A$), as shown in the derivation of the equilibrium (see Appendix). For $\gamma = 0$, the critical value becomes zero, $c'_A = 0$. This implies that for $\gamma = 0$, the demand for low quality becomes positive for any level of costs, $c_A \geq 0$:

$$\theta^*|_{\gamma=0} - \theta^L|_{\gamma=0} = \frac{(1 - m)c_A}{2(m - q_l)} > 0 \quad (3.34)$$

If, however, social preferences are strong ($\gamma = 1$), the cut-off point rises:

$$c'_A|_{\gamma=1} = \frac{m(m - q_l)}{m + q_l - 2m^2q_l} \quad (3.35)$$

Stronger social preferences require higher costs c_A for the inverse discount δ to induce a positive demand for low quality. Contrarily, the upper bound on c_A (necessary for a positive demand in the high value segment) is lower for $\gamma = 1$.

$$\begin{aligned} c''_A|_{\gamma=0} &= \frac{m - q_l}{1 - q_l} \\ c''_A|_{\gamma=1} &= \frac{(m - q_l)(m + q_l + 6mq_l + 4m^2q_l)}{m + (3 + m(6 + m))q_l - (2 + m(5 + 4m))q_l^2} \end{aligned} \quad (3.36)$$

Taking the effect on the optimal inverse discount and price into account, the interval in which a firm can implement a price discrimination strategy is smaller if consumers are

strongly concerned about others compared to purely selfish consumers. This can also be seen in the overview on equilibria displayed in Figures 3.14 and 3.15: The area of the pooling equilibrium with price discrimination is smaller for $\gamma = 1$.

Influence of Social Preferences on Profits and Equilibrium

If consumers are not inequity averse, the profits of the two types are reduced to:

$$\begin{aligned}\Pi_{PD}^A|_{\gamma=0} &= \frac{2m(m-c_A)^2 + (4mc_A - 2m^2 - c_A^2(1 + (2-m)m))q_l}{4m(m-q_l)} \\ \Pi_{PD}^B|_{\gamma=0} &= \frac{1}{4m(m-q_l)} \cdot [2c_Ac_B(1+m)(m-q_l)q_l \\ &\quad + 2m(m-q_l)(m-2c_Bq_l) + c_A^2(q_l - m(2 - (2-m)q_l))] \end{aligned} \quad (3.37)$$

Contrarily, for $\gamma = 1$, profits are given by:

$$\begin{aligned}\Pi_{PD}^A|_{\gamma=1} &= \frac{2(1+m)q_l(2m^2(m-q_l) - c_A(1+3m)(m-q_l) + c_A^2(1+m)(1 - (2-m)q_l))}{(m-q_l)(q_l + m(-1 + 8(1+m)q_l))} \\ \Pi_{PD}^B|_{\gamma=1} &= \frac{2q_l(1+m)}{(m-q_l)(q_l + m(-1 + 8(1+m)q_l))} \cdot [-c_A^2(1+m)(1 - (2-m)q_l) \\ &\quad + (m-q_l)(c_B(m-c_A) + 2m^2 + c_B(-1 + 3c_A - 2(2-c_A)m)q_l)] \end{aligned} \quad (3.38)$$

Given the restrictions of c_A in order to create positive demands for both goods ($c'_A < c_A < c''_A$), A is always better off if consumers are selfish and do not care about the price per quality paid by others: $\Pi_{PD}^A|_{\gamma=0} > \Pi_{PD}^A|_{\gamma=1}$.

The most important effect of social preferences on the equilibrium constellation is obtained through the change in the constraint of c'_A . The stronger the inequity aversion, the greater the lower boundary on the pooling equilibrium. Similarly, for the extreme case of $\gamma = 0$, price discrimination becomes feasible even for the lowest levels of costs c_A , as displayed in Figure 3.14.

If, however, consumers care a lot for the price-quality ratios of other consumers ($\gamma = 1$), the area in which price discrimination constitutes a pooling equilibrium changes. The strong social preferences limit the feasibility of price discrimination and put a lower bound

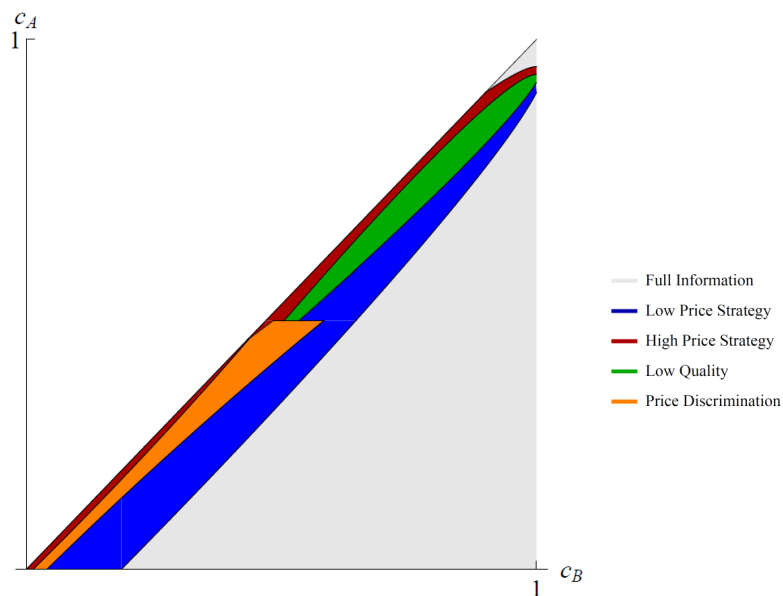


Fig. 3.14: Overview on Equilibria for Purely Selfish Consumers, $m = 0.98$, $q_l = 0.95$ and $\gamma = 0$

on the equilibrium, while the upper bound of c_A'' is decreased.

3.7 Interpretation of the Findings

This model examines the optimal price and quality decisions of a monopolist with either high or low costs selling to consumers with inequity aversion. Nature determines whether the monopolist has high costs and can only produce low quality, or whether the monopolist has low costs and can choose between high, low or both levels of quality.

The good offered to consumers constitutes a search good if information is distributed symmetrically, so that consumers can perfectly evaluate the quality of goods before the purchase. Under this assumption of full information, a high cost seller produces low quality, while the low cost seller offers high quality for all levels of costs. Type A is always better off to sell only high quality and thus refrains from offering a second good of lower quality and price discriminating among consumers.

Having the results of the first-best case as a benchmark in mind, the introduction of an asymmetric distribution of information then models the market for experience goods. The first-best equilibrium survives for some levels of costs c_A even under quality uncertainty. This is due to the fact that price and quality decisions are fixed and the interaction with

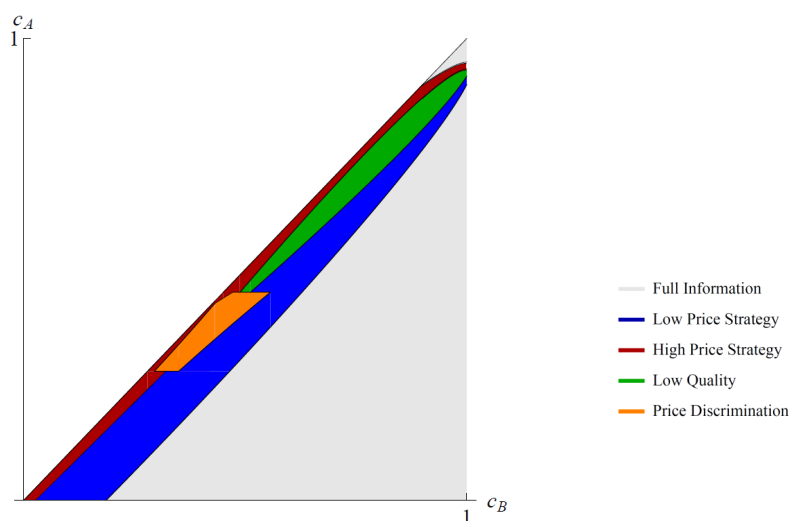


Fig. 3.15: Overview on Equilibria for Socially Concerned Consumers, $m = 0.98$, $q_l = 0.95$ and $\gamma = 1$

consumers is repeated. As a consequence, B suffers in the second period from imitating the high quality producer

Since a high cost monopolist can benefit from uncertain quality in the first period (due to the increased willingness to pay of consumers relative to the revelation of low quality), he has an incentive to imitate a low cost producer under some circumstances. In turn, the low cost monopolist might want to engage in costly signals in order to successfully separate from a high cost type in equilibrium. Often, A finds it profitable to separate with a signaling price (p_{S1}^A or p_{S2}^A). In this case, consumers infer that the monopolist has low costs and offers a high quality good. The model shows that both a *high* and a *low* price strategy might be implemented by the high quality seller in order to signal the true product attributes. A fourth separating equilibrium exists in which both types offer low quality if c_B and q_l are large enough. Consumers benefit from a lower level of q_l if the monopolist has low cost and thus sells high quality at either p_{S1}^A or p_{S2}^A , as prices are lowered.

The ex-ante quality uncertainty is not resolved if A decides to price discriminate and B sets the same price and inverse discount. While A sells a high quality for the higher price, B provides only low quality. Furthermore, in this model consumers are not only concerned about their own material payoff but also care about the price that others pay for a particular quality level. For that reason, consumers of the high value segment suffer a

loss in utility which needs to be considered by the monopolist in the price setting decision. The analysis of the parameter γ shows that strong social preferences reduce the price for the high quality item and increase the value of δ , effectively reducing the differences in prices. Whether the number of customers buying high quality increases or decreases for strong social preferences depends on the level of costs; the adjustments in price and discount may even lead to *more* consumers buying high quality compared to the case of purely selfish consumers.

The price discrimination strategy constitutes a pooling equilibrium in this game. The low cost monopolist, however, does not implement a price discrimination strategy in order to signal the true quality of the goods and successfully separate from a high cost type. Relative to pooling with uniform pricing, the discrimination allows A to exploit the heterogeneity among consumers. A's profit from price discrimination is thus strictly larger than that from uniform pricing (see Appendix 8.1.8).

The pooling equilibrium with price discrimination requires sufficiently high levels of q_l and μ , respectively. Otherwise, the equilibrium no longer survives, so that a low cost monopolist sells only high quality – either at the full information price or at one of the two signaling prices –, while the high cost monopolist reveals his low quality from the beginning on.

3.8 Extension: Long-Term Oriented Consumers

The model can be easily extended with respect to the time preferences of consumers. It is sometimes reasonable to think of consumers who consider the long-run effects of their purchase decisions. That is, they could maximize their total utility over several periods rather than making short run decisions. This seems to be especially realistic when consumers know that they only find out about the true quality of products through consumption. Purchasing a product of unknown quality now influences the knowledge and thus the expected utility in the future. If consumers account for their overall utility over both periods, the findings remain the same in those cases in which the low cost monopolist offers only one good. For the case of a pooling equilibrium with price discrimination, nevertheless, the expected utility functions are given by:

$$\begin{aligned}
Eu_H &= \theta m - p - \gamma \left(\frac{p}{m} - \frac{\delta p}{q_l} \right) + \theta m - p \\
Eu_L &= \theta q_l - \delta p + \theta m - p
\end{aligned} \tag{3.39}$$

While the marginal consumer θ^* is the same for both short-term and long-term oriented consumers, the location of the marginal consumer θ^L is shifted upwards, ceteris paribus:

$$\theta^L = \frac{p(1 + \delta)}{m + q_l} \tag{3.40}$$

In this case, the indifferent consumer is given by the ratio of the sum of prices to the sum of (expected) qualities. This change in the demand for the low quality good affects the optimal price and inverse discount, as well as the resulting profit of A.

$$\begin{aligned}
p_{PD}^{LT} &= \frac{mB}{m^2 q_l^2 (15m + 17q_l) + 2mq_l (m + q_l) (3m + 5q_l) \gamma - (m - q_l) (m + q_l)^2 \gamma^2} \\
\delta_{PD}^{LT} &= \frac{q_l}{mB} \cdot [2m (mq_l (m + q_l) (m + 3q_l) + (m + q_l)^3 \gamma) \\
&\quad + c_A m q_l (q_l^2 + m^2 (-2 + 8q_l) + m q_l (-1 + 10q_l)) \\
&\quad + c_A ((m + q_l) (q_l^2 + m^2 (-2 + 4q_l) + m q_l (-2 + 7q_l)) \gamma - (1 - q_l) (m + q_l)^2 \gamma^2)]
\end{aligned} \tag{3.41}$$

with

$$\begin{aligned}
B &= m q_l^2 (8m (m + q_l) + c_A (7q_l + m (7 + 2q_l))) - c_A (1 - q_l) (m + q_l)^2 \gamma^2 \\
&\quad + q_l (m + q_l) (2c_A m + 3c_A (1 + m) q_l + 4m (m + q_l)) \gamma
\end{aligned}$$

Serving long-term oriented consumers yields the profit

$$\begin{aligned}
\Pi_{PD}^A = & \frac{2q_l (2mq_l + (m + q_l) \gamma)}{\left(m^2 q_l^2 (15m + 17q_l) (m - q_l) + 2mq_l (m^2 - q_l^2) (3m + 5q_l) \gamma - (m^2 - q_l^2)^2 \gamma^2 \right)} \\
& \cdot \left[2m^2 (m^2 - q_l^2) + c_A (m - q_l) (m (m (-4 + q_l) - 5q_l) - (1 - m) (m + q_l) \gamma) \right. \\
& + c_A^2 (q_l (-q_l + (1 - q_l) \gamma) + m^2 (2 - \gamma + q_l (-1 + 2q_l + \gamma))) \\
& \left. + c_A^2 m (\gamma + q_l (1 - 3q_l - (2 - q_l) \gamma)) \right]
\end{aligned} \tag{3.42}$$

Figure 3.16 shows that the optimal price and inverse discount as well as the resulting profit for short-term oriented consumers differ only slightly from those obtained for long-term oriented ones.

	Short-Term Consumers	Long-Term Consumers
p	0.7148	0.7146
δ	0.9642	0.9666
Π_{PD}^A	0.1439	0.1435

Fig. 3.16: Comparison of Results for Short-Term and Long-Term Oriented Consumers, $m = 0.98$, $q_l = 0.95$, $\gamma = 0.2$ and $c_A = 0.45$.

The qualitative results of the equilibrium analysis are very similar to those for short-term oriented consumers and thus will not be further outlined at this point. For that reason, the detailed equilibrium analysis in Section 3.4 followed the standard economic models in assuming that consumers are myopic and make their purchase decision for the current period of consumption.

Duopoly with Exogenous Quality

4.1 Motivation

The previous chapter has modeled a monopoly in which the seller can have high or low costs, addressing the question of how quality uncertainty affects the quality and price decisions of the monopolist when consumers exhibit social preferences. The aim of this chapter is now to analyze the impact of social preferences on the optimal prices in a competitive setting. For simplicity, the basic model derived in this section abstracts away from quality uncertainty: Consumers have perfect information about the costs of the two sellers and can therefore infer the qualities chosen before the purchase. The former model is transferred to a competitive setting with perfect information. The two firms again differ with respect to their variable costs and the quality levels they can provide. Qualities are defined exogenously as q_h and q_l and the two firms compete in prices.

What are the optimal pricing strategies in a two period model if the two types introduced in the previous chapter are now competitors in a duopoly? In order to answer the question, the following model applies the same structure as the monopoly model under perfect information. While the monopoly model identifies only one equilibrium under first-best (where A sells high quality and B sells low quality), the following analysis will show that different equilibria can arise in a competitive environment. Moreover, due to the asymmetry in costs two different market structures can exist: Either both firms sell or Firm A becomes a monopolist by driving Firm B out of the market with too low prices.

4.2 Introduction to the Model

4.2.1 Assumptions of the Model

Consumers Characteristics

Consumers have heterogeneous preferences for quality, measured by the parameter θ , $\theta \in [0, 1]$. Individuals with a higher value of θ have a higher utility from consuming a particular quality or, put differently, individuals with a higher θ are willing to pay a higher price for the same quality. The number of consumers is normalized to one and they are uniformly distributed along the interval $[0, 1]$. Consumers' acquisition utility from purchasing a good with quality q_j at price $p_{q_j}^i$ is given by

$$Eu = \theta q_j^i - p_{q_j}^i \quad (4.1)$$

with $j = l, h$ and $i = A, B$. Individuals are assumed to have a unit demand in each period and they buy a product if their utility is nonnegative. Similar to the monopoly model, consumers are inequity averse in the sense that their utility decreases if they pay a higher price per quality than individuals buying a different good. In this case, the utility functions of consumers buying from Firm A are:

$$\begin{aligned} Eu_H &= \theta q_h - p_{PD,H}^A - \gamma \left(\frac{p_{PD,H}^A}{q_h} - \frac{p_{PD,L}^A}{q_l} \right) \\ Eu_L &= \theta q_l - p_{PD,L}^A \end{aligned} \quad (4.2)$$

The superscript again denotes the Firm, whereas the subscript "PD" describes the price strategy employed (price discrimination). The price for high quality (low quality) is denoted by $p_{PD,H}$ ($p_{PD,L}$). Contrarily to the monopoly model, the disadvantageous inequity aversion now also plays a role when the two firms offer different qualities and their price-quality ratios differ. If the two firms differentiate, so that Firm A offers q_h at price p_D^A and Firm B provides q_l at price p_D^B , consumers derive the following utilities from buying high or low quality:

$$\begin{aligned}
Eu_H &= \theta q_h - p_D^A - \gamma \left(\frac{p_D^A}{q_h} - \frac{p_D^B}{q_l} \right) \\
Eu_L &= \theta q_l - p_D^B
\end{aligned}
\tag{4.3}$$

If some consumers buy the high quality product while others purchase a low quality good, the first ones are called *high value segment*, while the others are referred to as *low value segment*. Note that the market will be uncovered in equilibrium and some consumers with a very low θ do not buy at all.

Firm Characteristics

On the seller side, there are two producers A and B with asymmetric variable costs of quality. While Firm A has low costs denoted by c_A , Firm B faces high costs c_B ($0 \leq c_A \leq c_B \leq 1$). The product quality can take only two values, $q_h = 1$ and $q_l < 1$, which are exogenously given. Fixed costs are assumed to be zero for both types. Analogous to the monopoly model, Firm B can only produce low quality goods. Firm A can decide whether to sell high quality, low quality or both high and low quality goods. In the price discrimination scenario, the model again assumes that the additional product is only offered in the first period¹.

4.2.2 Timing of the Game

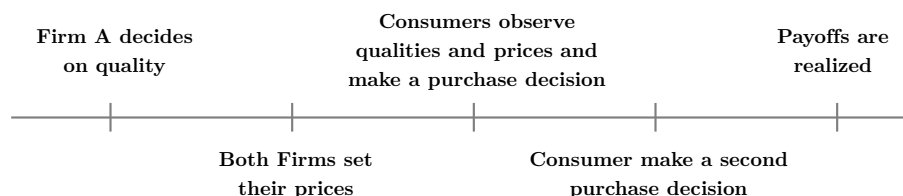


Fig. 4.1: Timing of the Game

Figure 4.1 summarizes the stages of the interaction. The timing as follows: In the first stage, Firm A chooses which quality to offer. Secondly, both firms set their optimal prices

¹ It might be argued that the introduction of a second period plays a minor role under perfect information. In this case, it is added in order to make the model more comparable to the one derived in Section 3. Reducing the model to one period would change the optimal price for high quality and consequently the profit in case of price discrimination, while other results would remain the same.

simultaneously. In the third and fourth stages, consumers make a purchase decision. Last, firms and consumers realize their payoffs.

4.3 Analysis of the Model

Compared to the monopoly, different equilibria can arise when two firms compete in prices and information is symmetrically distributed. If Firm A has a cost advantage, it can become a monopolist by setting a price that is too low for Firm B to yield a positive profit margin. On the other hand, if they face the same costs, $c_A = c_B$, only one equilibrium exists.

Proposition 7. *An equilibrium exists in which Firm A offers high quality at price p_D^A and Firm B offers low quality at price p_D^B if both firms have the same level of costs, $c_A = c_B$.*

PROOF: SEE APPENDIX

If costs are symmetric ($c_A = c_B \equiv c$), it is optimal for both firms to differentiate in qualities in order to soften the effects from price competition and improve profits. Firm A chooses high quality and sets $p = p_D^A$, while Firm B sells its low quality at price $p = p_D^B$. In this case, the marginal consumers θ^* and θ^L are characterized as:

$$\begin{aligned}\theta^* &= \frac{(p_D^A - p_D^B) q_l + (p_D^A q_l - p_D^B) \gamma}{(1 - q_l) q_l} \\ \theta^L &= \frac{p_D^B}{q_l}\end{aligned}\tag{4.4}$$

Consumers with high preferences ($\theta \in [\theta^*, 1]$) select the high quality product, whereas those with a lower preference ($\theta \in [\theta^L, \theta^*]$) buy the low quality good. The two firms maximize their profits if A charges the price p_D^A , while B sets p_D^B :

$$\begin{aligned}p_D^A &= \frac{2(1 - q_l) + c(2 + q_l + 3\gamma)}{4 - q_l + 3\gamma} \\ p_D^B &= \frac{q_l(1 - q_l + 3c(1 + \gamma))}{4 - q_l + 3\gamma}\end{aligned}\tag{4.5}$$

The two firms realize profits Π_D^A and Π_D^B :

$$\begin{aligned}\Pi_D^A &= \frac{8(1-c)^2(1-q_l)(1+\gamma)}{(4-q_l+3\gamma)^2} \\ \Pi_D^B &= \frac{2(1-c)^2(1-q_l)q_l(1+\gamma)}{(4-q_l+3\gamma)^2}\end{aligned}\tag{4.6}$$

The profit of Firm A is more than four times higher than the profit of Firm B if costs are symmetric and the sellers differentiate vertically.

Contrarily, if the two firms are asymmetric and Firm A has a cost advantage, it can set a very low price that would result in a negative profit margin of Firm B. In this case, B would decide not to sell at all². In case of ex-ante asymmetry, two equilibria can arise, depending on the level of costs.

Proposition 8. *An equilibrium exists in which Firm A becomes a monopolist and sells high quality at price $p_{PD,H}^A$ and low quality in the first period at price $p_{PD,L}^A$ for $c_A \in [c_A^*, c_B]$.*

PROOF: SEE APPENDIX

If A wants to drive Firm B out of the market using price discrimination, the low quality product needs to be offered slightly below the marginal costs of Firm B. That is, the optimal prices for the two goods are:

$$\begin{aligned}p_{PD,H}^A &= \frac{2 + c_B\gamma + c_A(1-q_l)(2+\gamma) - q_l(2 - c_B(2+\gamma))}{2(2 - q_l + \gamma)} \\ p_{PD,L}^A &= c_Bq_l\end{aligned}\tag{4.7}$$

The demand for both goods is only positive if $c_A > c_A^*$:

$$c_A^* = \frac{-2 + 4c_B + c_B\gamma}{2 + \gamma}\tag{4.8}$$

Firm B does not sell and receives zero profit. Firm A obtains the positive profit Π_{PD}^A :

² In the following, it is assumed that B decides not to sell on the market whenever the profit is zero. This leads to the same result as assuming that A sets a price that is equal to the marginal costs of B *minus* a small ϵ and let ϵ converge to zero (see for instance Shapiro (1989)).

$$\begin{aligned} \Pi_{PD}^A = & \frac{1}{4(2 - q_l + \gamma)} \cdot [4(1 - c_A)^2 + \gamma^2(c_B - c_A)^2(1 - q_l) \\ & - 4((1 - c_B)^2 + (c_B - c_A)^2)q_l + 4\gamma(c_B - c_A)(1 - c_A(1 - q_l) + q_l - 2c_Bq_l)] \end{aligned} \quad (4.9)$$

If costs are sufficiently large, A becomes a monopolist by offering two goods. The extreme price for the low quality good makes Firm B indifferent between selling and staying out of the market. Relative to the price for low quality (which only depends on c_B and q_l) the price for high quality is affected by the cannibalization effect and consumers' inequity aversion. Nevertheless, it is the optimal strategy for Firm A that leads to both monopoly power and profitability from selling high quality.

Whenever price discrimination is not feasible, because the low quality good would not be bought by consumers ($c_A < c_A^*$), Firm A becomes a monopolist by selling high quality only.

Proposition 9. *An equilibrium exists in which A becomes a monopolist and sells high quality at price p_{M,q_h}^A for $c_A \in [0, c_A^*]$.*

PROOF: SEE APPENDIX

When Firm A wants to put Firm B out of the market by selling high quality only, consumers may not have an incentive to purchase low quality. This is given when $\theta^* = \theta^L$. Solving the equation for p^B yields $p^B = p^A q_l$. The price for which B cannot sell a unit of low quality (because all consumers would decide for the high quality good offered by A) is therefore:

$$p_{M,q_h}^A = c_B \quad (4.10)$$

If B wanted to induce consumers to decide for the low quality good, the price would have to be lower than $c_B q_l$ which results in a negative profit margin. By that, Firm A becomes a monopolist and sells high quality, resulting in the profit Π_M^A :

$$\Pi_{M,q_h}^A = 2(c_B - c_A)(1 - c_B) \quad (4.11)$$

4.4 Summary of the Results

For symmetric costs, firms differentiate in qualities and split the market (red line). However, if Firm A has a cost advantage, it will always endogenously emerge as monopolist by selling either high quality when costs are too low, $c_A < c_A^*$ (dark gray area) or high and low quality products when costs are in a medium range, $c_A^* < c_A < c_B$ (gray area). Both strategies require to set a low price for the high or low quality product, respectively, so that Firm B has no incentive to compete for consumers. Figure 4.2 provides an overview on the resulting equilibria depending on the cost levels c_A and c_B .

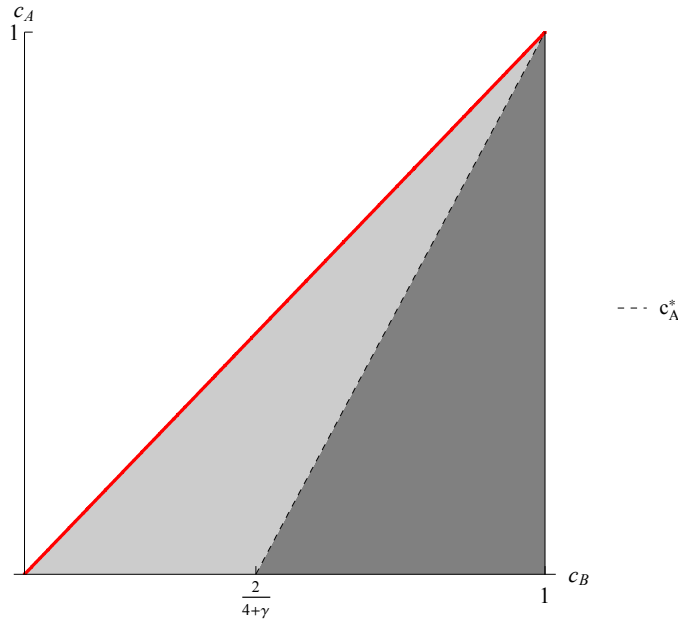


Fig. 4.2: Overview on Equilibria, $\gamma = 0.5$ and $q_l = 0.9$

This implies that consumers can always buy a high quality good, regardless of the cost levels. Moreover, they can choose among two product variants as long as $c_A > c_A^*$. Note that A would strictly prefer the second strategy and weaken the reduction in the profitability of selling high quality:

$$\Pi_{PD}^A - \Pi_{M,q_h}^A = \frac{(1 - q_l) (2 + c_A (2 + \gamma) - c_B (4 + \gamma))^2}{4 (2 - q_l + \gamma)} > 0 \quad (4.12)$$

Driving Firm B out of the market by offering one product at a low price thus only constitutes an equilibrium in this game because for some levels of costs consumers do not

demand both qualities and the self-selection constraint would not hold.

4.5 Comparative Analysis

The equilibrium analysis demonstrates that both market structures can arise in equilibrium due to the asymmetry in costs. The most interesting influencing factors in this duopoly model are the strength of social preferences and the level of costs c_B , as the level of low quality q_l only affects the optimal prices but not the general equilibrium constellations³. The parameter γ affects both the equilibrium with quality differentiation and the equilibrium featuring a price discrimination strategy. For the two equilibria under asymmetric costs, the value of c_B plays a major role, as it determines the price Firm A must set for its products in order to drive Firm B out of the market. The impact of these two parameters is further discussed below.

4.5.1 Influence of Social Preferences

Influence on Equilibrium with Differentiation

When costs are symmetric, the low cost firm offers high quality and the high cost one provides low quality. The strength of social preferences influences both prices negatively:

$$\begin{aligned}\frac{\partial p_D^A}{\partial \gamma} &= -\frac{6(1-c)(1-q_l)}{(4-q_l+3\gamma)^2} < 0 \\ \frac{\partial p_D^B}{\partial \gamma} &= -\frac{3q_l(1-c)(1-q_l)}{(4-q_l+3\gamma)^2} < 0\end{aligned}\tag{4.13}$$

The reduction in the price for high quality is more severe than for low quality. Social preferences decrease the willingness of consumers to pay for high quality. Since Firm A lowers its price, Firm B needs to respond similarly. However, the reduction in prices offsets the effect on willingness to pay, so that both demands increase in γ :

³ The critical value c_A^* only depends on γ and c_B .

$$\begin{aligned}\frac{\partial \theta^*}{\partial \gamma} &= -\frac{2(1-c)(1-q_l)}{(4-q_l+3\gamma)^2} < 0 \\ \frac{\partial \theta^L}{\partial \gamma} &= -\frac{3(1-c)(1-q_l)}{(4-q_l+3\gamma)^2} < 0\end{aligned}\tag{4.14}$$

The effect on θ^L is larger than the effect on θ^* , implying that both demands increase for stronger social preferences. Firms, however, suffer a loss in profits, as the additional demand does not make up for the loss in profit margin:

$$\begin{aligned}\frac{\partial \Pi_D^A}{\partial \gamma} &= -\frac{8(1-c)^2(1-q_l)(2+q_l+3\gamma)}{(4-q_l+3\gamma)^3} < 0 \\ \frac{\partial \Pi_D^B}{\partial \gamma} &= -\frac{2(1-c)^2(1-q_l)q_l(2+q_l+3\gamma)}{(4-q_l+3\gamma)^3} < 0\end{aligned}\tag{4.15}$$

The profit reduction from stronger social preferences is more severe for Firm A which serves the segment paying a higher price per quality.

Influence on Equilibrium with Price Discrimination

If consumers are more averse against disadvantageous inequity, their willingness to pay for high quality falls. How does that change the optimal price for high quality when Firm A price discriminates? Intuitively, Firm A needs to lower the price $p_{PD,H}^A$ in order to maximize profits:

$$\frac{\partial p_{PD,H}^A}{\partial \gamma} = -\frac{(1-q_l)(2+c_Aq_l-c_B(2+q_l))}{2(2-q_l+\gamma)^2} < 0\tag{4.16}$$

Since the price for the low quality good remains the same regardless of the inequity aversion, a change in social preferences needs to result in higher demand for one good and lower demand for the other one, while the total number of consumers who buy a good is constant. Thus, social preferences only affect *which* good some of the consumers prefer to acquire from the discriminating monopolist A.

Whether the demands for the two goods rise or fall with an increase in social preferences depends on the level costs c_A . Two opposing effects can be identified: on the one hand,

the marginal consumer θ^* would rise with stronger social preferences (demand effect). On the other hand, the price falls as a response to a higher γ (price effect). Which of the two effects dominates depends on c_A . In particular, for $c_A < c'_A$, the demand for high quality (low quality) rises (falls) in γ , while for $c_A > c'_A$ the effect is reverse⁴:

$$c'_A = c_B - \frac{2(1 - c_B)(1 - q_l)}{(2 + \gamma)^2 - q_l(3 + 2\gamma)} \quad (4.17)$$

This finding is similar to the comparison of demand for high quality under extreme values of γ in the monopolistic model. The effect of stronger social preferences on the profit of Firm A from price discrimination is intuitive: it needs to lower the price without attracting additional customers. For that reason, the effect of γ on the profit is negative, but decreasing:

$$\begin{aligned} \frac{\partial \Pi_{PD}^A}{\partial \gamma} &= -(1 - q_l) \\ &\quad \cdot \frac{(2 + c_A(2 + \gamma) - c_B(4 + \gamma))(2 - c_A(2 - 2q_l + \gamma) - c_B(2q_l - \gamma))}{4(2 - q_l + \gamma)^2} < 0 \quad (4.18) \\ \frac{\partial^2 \Pi_{PD}^A}{\partial^2 \gamma} &= \frac{(1 - q_l)(2 + c_A q_l - c_B(2 + q_l))^2}{2(2 - q_l + \gamma)^3} > 0 \end{aligned}$$

Note that the fractions are positive for all values $c_A \in (c_A^*, c_B)$.

4.5.2 Influence of Costs of Quality

Influence on Equilibrium with High Quality

The second important parameter affecting the optimal prices and profits in equilibrium is the variable costs of quality c_B . The effects of higher costs c_B on the equilibrium in which A sells only high quality are intuitive: the price p_{M,q_h}^A increases linearly in c_B , whereas the effect on the profit is negative for sufficiently small costs:

$$\frac{\partial \Pi_{M,q_h}^A}{\partial c_B} = 2(1 + c_A - 2c_B) < 0 \quad \forall c_A < 1 - 2c_B \quad (4.19)$$

⁴ Since $c'_A > c_A^*$, both effects can arise when price discrimination is feasible.

Influence on Equilibrium with Price Discrimination

How do higher costs c_B affect the equilibrium with price discrimination? Since A wants to drive B out of the market, the costs c_B are a critical factor for succeeding in this strategy. The influence of c_B on $p_{PD,H}^A$ and $p_{PD,L}^A$ is positive:

$$\begin{aligned}\frac{\partial p_{PD,H}^A}{\partial c_B} &= \frac{q_l(2+\gamma) + \gamma}{2(2-q_l+\gamma)} > 0 \\ \frac{\partial p_{PD,L}^A}{\partial c_B} &= q_l > 0\end{aligned}\tag{4.20}$$

The higher the costs Firm B faces, the higher the price that Firm A can set in order to become a monopolist and maximize its profit. But how does the higher level of costs affect the overall profit of Firm A?

$$\begin{aligned}\frac{\partial \Pi_{PD}^A}{\partial c_B} &= \frac{1}{2(2-q_l+\gamma)} \left[\gamma(2(1-c_A) + (c_B - c_A)\gamma) \right. \\ &\quad \left. + q_l(2(2+\gamma) + c_A(4+\gamma(6+\gamma)) - c_B(8+\gamma(8+\gamma))) \right]\end{aligned}\tag{4.21}$$

The derivative is positive for $c_A > \hat{c}_A$:

$$\hat{c}_A = \frac{q_l(c_B(8+\gamma(8+\gamma)) - 2(2+\gamma)) - \gamma(2+c_B\gamma)}{q_l(4+\gamma(6+\gamma)) - \gamma(2+\gamma)}\tag{4.22}$$

That implies that Firm A cannot always benefit from the increasing costs of its competitor when it wants to eliminate the competition by offering two products.

4.6 Interpretation of the Findings

The model analyzes how two firms with asymmetric costs and different opportunities regarding the provision of quality behave in a competitive market. The more efficient Firm prefers to introduce two goods in the first period and by that successfully deters Firm B from selling in the market. The strategy allows to eliminate competition, but at the same time maintains a reasonable profit margin for the high quality good. Social preferences affect the level of costs for which Firm A can implement a price discrimination strategy.

Moreover, the higher γ , the lower the price for high quality and the lower the profit of Firm A. This price reduction may even result in a *higher* demand for high quality. When a price discrimination strategy is not feasible, Firm A becomes a monopolist by selling high quality at a sufficiently low price. If firms are symmetric in costs, they prefer to differentiate in qualities. In this case, Firm A suffers more when consumers care more for the relative price-quality ratios. Under full information, consumers can always purchase a high quality item and in most of the cases choose between two product variants – a result significantly differing from the monopoly model.

4.7 Limitations of the Model

Compared to the model derived in Section 3, this model is based on symmetrically distributed information, so that consumers can evaluate the quality of the goods before the purchase. By that, there is no need for Firm A to engage in costly signaling in order to convey information about its type. While the assumption of perfect information substantially facilitates the equilibrium analysis, it might not be true for many products in real life, where consumers cannot ascertain the product quality before the purchase.

Another drawback of the model concerns the incorporation of quality as exogenously given. A firm might not only want to maximize its profit by setting the optimal price but also consider the optimal level of quality. This model, contrarily, assumes that product quality can either be high or low which constitutes a major simplification.

5

Duopoly with Endogenous Quality

5.1 Motivation

The models derived in Sections 3 and 4 were based on the same simplifying assumption, namely that product quality can take only two values (q_h and q_l) which are exogenously given. In reality, however, firms often use the product quality strategically in order to maximize their profits. The following model analyzes the optimal quality choices of two duopolists which compete in prices.

Additionally, this model considers third-degree price discrimination in the form of two separate markets where consumers can neither switch nor arbitrage. That is, consumers can only buy the products offered in their own market segment. Examples for this form of price discrimination are specific menus for children in a restaurant which cannot be ordered by adults or prices based on gender, for example when prices for a basic white shirt of the same brand differ for male and female items. Consumers might also derive a disutility from paying a higher price than students when going to the cinema. The aim of the model is to study the role of social preferences on the quality and price choices of the two firms in two separate markets. Do social preferences raise or lower the optimal quality levels? How do they affect the optimal prices when these are not subject to a cannibalization effect?

5.2 Introduction to the Model

5.2.1 Assumptions of the Model

Consumers Characteristics

There are two markets, called Market 1 and Market 2. Each market consists of a unit mass of consumers who are heterogeneous in their preferences for quality. These preferences are again measured by the parameter θ , with $\theta \in [0, 1]$. Each consumer buys at most one product. While Market 1 is only served by Firm A, products of both Firm A and Firm B are sold in Market 2. This assumption is crucial, since it determines the set of options consumers in each segment have. Moreover, it causes differences in the utility functions of consumers in Market 1 and of those belonging to Market 2.

The utility of consumers in Market 2 solely depends on the product they buy. Let p_m^i denote the price of Firm i charged in Market m with $i = A, B$ and $m = 1, 2$. p_2^B thus denotes the price charged by Firm B in Market 2. Similarly, q_m^i describes the quality of Firm i selected in Market m , so that q_2^A for example describes the quality offered by Firm A in Market 2. U_m^i describes the utility of consumers buying from Firm i in Market m , implying that U_2^B (U_2^A) denotes the utility of consumers who purchase from Firm B (A) in Market 2:

$$\begin{aligned} U_2^A &= \theta q_2^A - p_2^A \\ U_2^B &= \theta q_2^B - p_2^B \end{aligned} \tag{5.1}$$

Without loss of generality, assume that Firm A provides the higher quality and Firm B sells the lower quality¹. In Market 2, there are two marginal consumers. θ^* describes the consumer who is indifferent between buying from Firm A and buying from Firm B. θ^L describes the consumer who still buys a unit from Firm B. They are given by the following terms:

¹ This order of quality levels naturally emerges from the assumption that Firm A selects its quality first and thus decides to offer the higher quality, as shown later in the model.

$$\begin{aligned}\theta^* &= \frac{p_2^A - p_2^B}{q_2^A - q_2^B} \\ \theta^L &= \frac{p_2^B}{q_2^B}\end{aligned}\tag{5.2}$$

These expressions reflect the standard results obtained in duopolistic markets of quality differentiation, see for instance Choi and Shin (1992). Consumers with a high preferences, $\theta^* \leq \theta \leq 1$, buy from Firm A, whereas consumers with lower preferences, $\theta^L \leq \theta < \theta^*$, buy from Firm B. Nevertheless, this model introduces two market segments. It is assumed that consumers can observe the prices and qualities provided in the other market. This assumption is reasonable, because prices are publicly announced most often (student discounts at a theater can be seen by any visitor, for instance).

The two markets do not only differ with respect to the number of firms offering their products but also with respect to the preferences of consumers. In particular, consumers in Market 2 are assumed to be purely selfish, whereas consumers in the monopolistic market (Market 1) compare their own price-quality ratio to that of consumers buying from the same Firm A in the other market. Male customers might be upset that trousers are more expensive than women's of the same brand; normal customers are envious because students pay a lower price for the same seat when going to the cinema. In Market 1, the price (quality) of Firm A is expressed by p_1^A (q_1^A). Consumers in Market 1 have the following utility function:

$$U_1 = \theta q_1^A - p_1^A - \gamma \left(\frac{p_1^A}{q_1^A} - \frac{p_2^A}{q_2^A} \right)\tag{5.3}$$

The utility function points out that consumers compare their own price-quality ratio ($\frac{p_1^A}{q_1^A}$) to that of consumers buying from the same Firm A in Market 2 ($\frac{p_2^A}{q_2^A}$). Paying a higher price per quality than consumers in Market 2 buying from Firm A, their utility from the transaction is reduced. Consumers with $\theta' \leq \theta \leq 1$ will buy a unit in Market 1:

$$\theta' = \frac{p_1^A q_2^A (q_1^A + \gamma) - \gamma p_2^A q_1^A}{(q_1^A)^2 q_2^A}\tag{5.4}$$

In total, there are three different consumer segments – two of which are served by Firm

A and one which buys from Firm B. Figure 5.1 provides an illustration of the two markets.

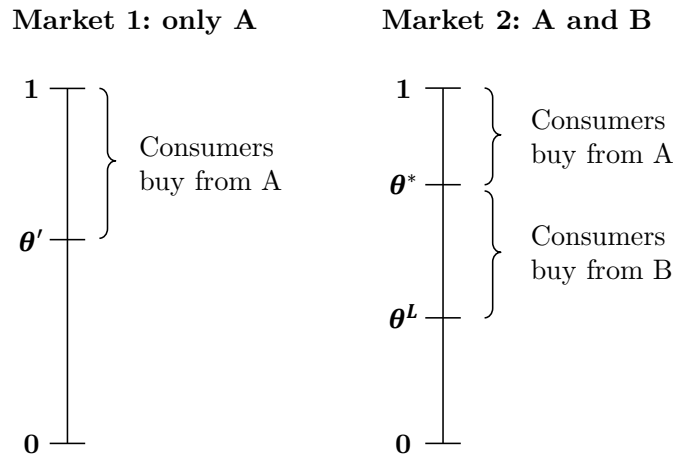


Fig. 5.1: Overview on Market Segments

Both markets will be uncovered in equilibrium, as it is not profitable for either of the two firms to sell even to those consumers with a very low taste for quality.

Firm Characteristics

For simplicity, both firms are assumed to have zero costs of production. While Firm B only earns from selling to consumers in Market 2, Firm A can yield a profit from selling in Market 1 and in Market 2. Their profit functions are therefore:

$$\begin{aligned}\Pi^A &= p_1^A (1 - \theta') + p_2^A (1 - \theta^*) \\ \Pi^B &= p_2^B (\theta^* - \theta^L)\end{aligned}\tag{5.5}$$

Firms maximize their profits by determining their optimal prices and levels of quality. The product quality q_m^i of Firm i is assumed to take values between zero and one. As a consequence of the similarity in exogenous parameters, differences in the profit from selling in Market 2 can only result from the temporal structure of decisions in the game.

5.2.2 Timing of the Game

The one-period model assumes that Firm A has a first mover advantage to the extent that it first determines its optimal levels of quality. In the first stage, Firm A sets the optimal quality q_1^A in Market 1. Second, it selects the level of quality in Market 2, q_2^A . Firm B observes these choices and chooses the quality of its product, q_2^B . In the fourth stage, both firms set prices for their products in both markets simultaneously. Consumers observe the prices and qualities and decide whether to buy – and in Market 2 which item to choose. Last, payoffs are realized.

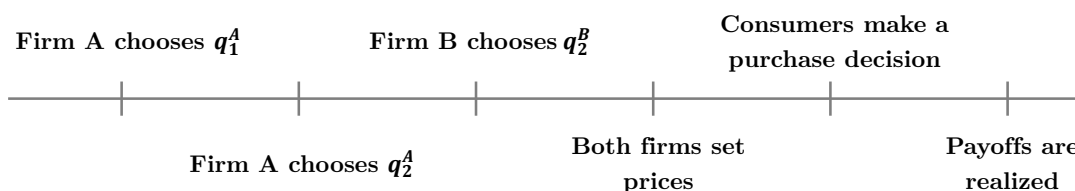


Fig. 5.2: Timing of the Game

The assumptions on consumers and the market structure only differ from standard models in the role of social preferences (γ). For $\gamma = 0$, two completely independent markets – one with a monopolist, the other one featuring two competitors – would be obtained. For that reason, differences from the standard results can only arise due to the influence of social preferences, γ . This structure of the game therefore allows for a specific analysis of the isolated parameter γ on the price and quality choices of the two firms in the context of third-degree price discrimination.

5.3 Analysis of the Model

The game is solved using backwards induction. Note that for the case of $\gamma = 0$, the two market segments are independent, implying one duopolistic and one monopolistic market with vertical differentiation. Taking the interdependent effects of their prices into account, the firms set their optimal prices p_1^A, p_2^A and p_2^B as functions of their qualities q_1^A, q_2^A and q_2^B and social preferences γ :

$$\begin{aligned}
p_1^A &= \frac{q_1^A q_2^A (4q_1^A q_2^A - q_1^A q_2^B + 2\gamma (q_2^A - q_2^B))}{2 \left(q_1^A q_2^A (4q_2^A - q_2^B) + \gamma \left(4 (q_2^A)^2 + \gamma q_2^B - q_2^A (q_2^B + \gamma) \right) \right)} \\
p_2^A &= \frac{q_2^A (q_2^A - q_2^B) (2q_1^A q_2^A + \gamma (q_1^A + 2q_2^A))}{q_1^A q_2^A (4q_2^A - q_2^B) + \gamma \left(4 (q_2^A)^2 + \gamma q_2^B - q_2^A (q_2^B + \gamma) \right)} \\
p_2^B &= \frac{q_2^B (q_2^A - q_2^B) (2q_1^A q_2^A + \gamma (q_1^A + 2q_2^A))}{2 \left(q_1^A q_2^A (4q_2^A - q_2^B) + \gamma \left(4 (q_2^A)^2 + \gamma q_2^B - q_2^A (q_2^B + \gamma) \right) \right)}
\end{aligned} \tag{5.6}$$

Given these best-response prices, both Firms determine their optimal product qualities sequentially.

Proposition 10. *Firm A will set the maximum levels of quality in both markets independent of the value of social preferences, whereas the quality of Firm B (q_2^B) decreases in γ .*

PROOF: See Appendix.

In the third stage, Firm B chooses its level of quality. Considering the choice of Firm A, Firm B sets the optimal quality q_2^{B*} :

$$q_2^{B*} = \frac{q_2^A (4q_1^A q_2^A + 4q_2^A \gamma - \gamma^2)}{7q_1^A q_2^A + 7q_2^A \gamma - \gamma^2} \tag{5.7}$$

Firm A anticipates the quality q_2^{B*} and maximizes its profit by setting the maximum level of quality in both markets:

$$q_1^A = q_2^A = 1 \tag{5.8}$$

This implies that the maximum quality is available to both segments. While Firm A's quality choice remains unaffected by the strength of social preferences, the lower quality in Market 2, q_2^B , is not, since it simplifies to:

$$q_2^B = \frac{4 + 4\gamma - \gamma^2}{7 + 7\gamma - \gamma^2} \tag{5.9}$$

For $\gamma = 0$, the standard results from Choi and Shin (1992) are obtained². The optimal prices are given by:

$$\begin{aligned} p_1^A &= \frac{8 + \gamma(10 + \gamma)}{4(1 + \gamma)(4 + (4 - \gamma)\gamma)} \\ p_2^A &= \frac{2 + 3\gamma}{8 + 2(4 - \gamma)\gamma} \\ p_2^B &= \frac{2 + 3\gamma}{28 + 28\gamma - 4\gamma^2} \end{aligned} \quad (5.10)$$

As outlined above, Firm A sells to two consumer segments and has a first mover advantage with respect to the quality choice. Firm B therefore realizes a smaller total profit:

$$\begin{aligned} \Pi^A &= \frac{5}{48(1 + \gamma)} + \frac{7(1 + \gamma)}{6(4 + (4 - \gamma)\gamma)} \\ \Pi^B &= \frac{(2 + 3\gamma)^2}{48(1 + \gamma)(4 + (4 - \gamma)\gamma)} \end{aligned} \quad (5.11)$$

The simplicity of the framework now also enables the analysis of consumer surplus and social welfare. The consumer surplus derived in the three segments is given by:

$$\begin{aligned} CS_1^A &= \frac{(8 + \gamma(10 + \gamma))(8 + \gamma(26 + \gamma(11 - 9\gamma)))}{32(1 + \gamma)(4 + (4 - \gamma)\gamma)^2} \\ CS_2^A &= \frac{(28 + \gamma(46 + \gamma(8 - 9\gamma)))(44 + \gamma(86 + \gamma(28 - 15\gamma)))}{288(1 + \gamma)^2(4 + (4 - \gamma)\gamma)^2} \\ CS_2^B &= \frac{(2 + 3\gamma)^2(7 + 7\gamma - \gamma^2)}{288(1 + \gamma)^2(4 + (4 - \gamma)\gamma)} \end{aligned} \quad (5.12)$$

The total consumer surplus is provided by the following expression:

$$CS = \frac{640 + \gamma(2080 + \gamma(1880 - 3\gamma(4 + \gamma(146 - 7\gamma))))}{96(1 + \gamma)(4 + (4 - \gamma)\gamma)^2} \quad (5.13)$$

Summing up the consumer surplus and firm profits yields the social welfare:

$$SW = \frac{1280 + \gamma(3872 + \gamma(3352 + 3\gamma(60 - \gamma(186 - 7\gamma))))}{96(1 + \gamma)(4 + (4 - \gamma)\gamma)^2} \quad (5.14)$$

² The authors obtain the value $q_2^B = \frac{4}{7}$ as the optimal level of low quality in a duopoly.

5.4 Comparative Analysis

The following section studies the influence of social preferences on the quality and price choices, consumer demand, firm profits and consumer welfare. First of all, the concern of some consumers for the price-quality ratio of others purchasing from the same firm significantly drive the optimal prices and the quality provided by Firm B. In particular, the quality q_2^B is inversely related to γ , as illustrated in Figure 5.3.

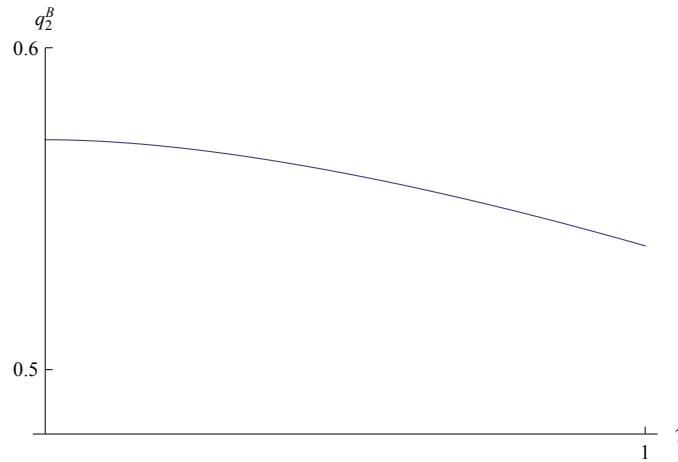


Fig. 5.3: Influence of Social Preferences on q_2^B

While Firm A needs to lower the price p_1^A in Market 1 for higher values of γ , it simultaneously raises the price in Market 2. This effectively decreases the difference in price-quality ratios. As a response, Firm B also increases its price p_2^B in Market 2. That implies that both prices in Market 2 rise, while the price for socially concerned consumers fall for higher levels of γ . The influence of γ on prices is illustrated by Figure 5.4.

Note that the monopoly price p_1^A might fall even below the competitive price p_2^A for strong social preferences (for $\gamma > \frac{2}{\sqrt{5}}$), which would lead to a *better* price-quality ratio in Market 1.

The stronger the social preferences, the lower the price p_1^A and the higher the prices p_2^A and p_2^B . Firm B optimally lowers the quality and further differentiates from Firm A. How do the changes in social preferences, prices and quality q_2^B affect the consumer demands? The decrease in p_1^A overcompensates for the decreased utility caused by the inequity aversion of consumers, leading to an *increase* in the demand of socially concerned

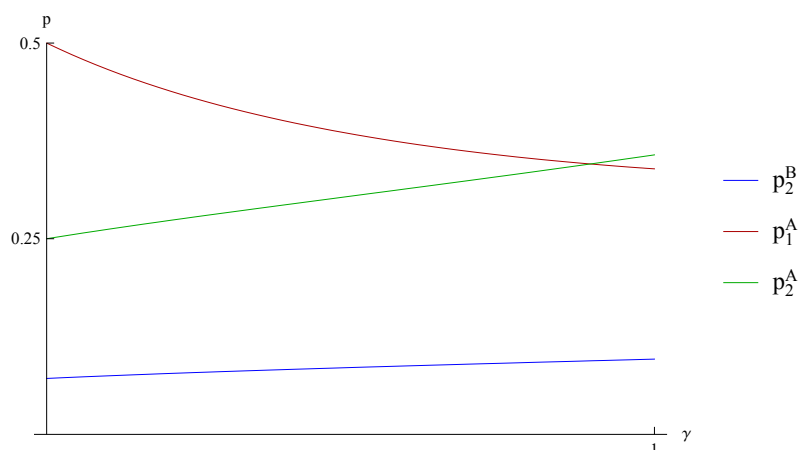


Fig. 5.4: Comparison of Prices

consumers for a higher level of social preferences ($\frac{\partial \theta'}{\partial \gamma} < 0$). Contrarily, Firm A sells fewer products in Market 2 for higher values of γ . Firm B can also benefit from a higher demand for its good (see Figure 5.5). While social preferences lead to more customers in Market 1, they decrease the total number of units bought in Market 2.

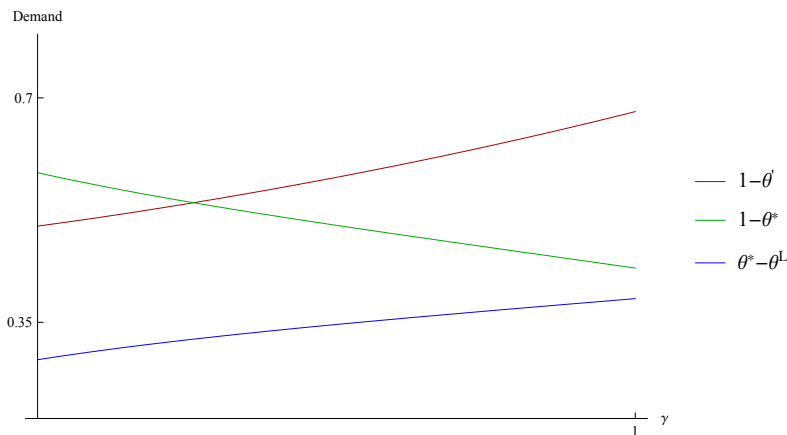


Fig. 5.5: Influence of Social Preferences on Demands

The effect of social preferences on consumer surplus is similar to that on the prices. While consumers in Market 1 benefit, high value consumers in Market 2 suffer from a higher level of γ . Additionally, due to the different effects on the prices p_1^A and p_2^A , consumers buying from Firm A in Market 2 may be worse off than consumers in the monopolistic market, if social preferences become too strong (see Figure 5.6). The total consumer surplus first increases and then decreases in γ , implying an inverted U-shape relationship.

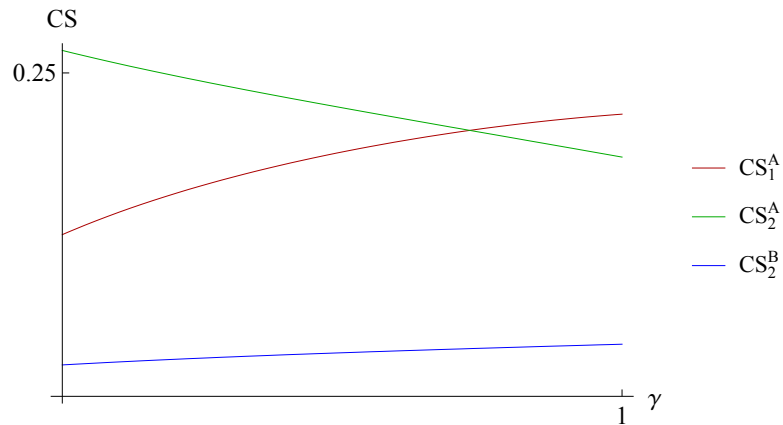


Fig. 5.6: Influence of Social Preferences on Consumer Surplus

The implications of stronger social preferences on the profits of the two firms are diverse. The profit of Firm A is the highest if consumers exhibit no social preferences, whereas Firm B can benefit from a higher γ (see Figure 5.7).

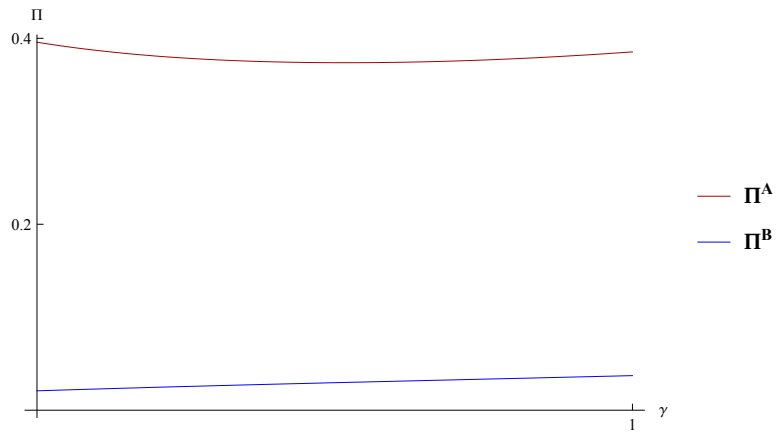


Fig. 5.7: Comparison of Profits

In total, the social welfare (the sum of firm profits and consumer surplus) is an increasing function of γ :

$$\frac{\partial SW}{\partial \gamma} = \frac{128 + \gamma (1088 + \gamma (2608 + 3\gamma (672 - \gamma (168 + \gamma (428 + 137\gamma))))}{96 (1 + \gamma)^2 (4 + (4 - \gamma) \gamma)^3} > 0 \quad (5.15)$$

As a result, society can benefit from socially concerned consumers in the context of

third-degree price discrimination due to the associated modifications in quality and prices.

5.5 Interpretation of the Findings

If consumers of one segment derive a disutility from paying a higher price per quality, the firm serving this segment actually decreases the price and by that raises the consumers' surplus, while the surplus of consumers in the duopolistic market is lowered through a corresponding change in prices. For very strong social preferences, the price in the monopoly might even fall below the one charged to consumers in the duopoly, despite the fact that qualities are the same in both markets. While the qualities of Firm A remain the same, the quality offered to low value consumers in the duopolistic market is reduced for higher levels of social preferences. It is Firm B that benefits from the social preferences displayed by consumers in a different market, namely by charging a higher price for a lower quality and selling to more consumers. Contrarily, the profit of Firm A decreases in social preferences.

Summing up, stronger social concerns of one consumer segment make the Firm serving only the other segment better off. Firm B reacts both with a price and a quality adjustment. Moreover, the purely self-interested customers who buy from the same firm as the socially concerned ones are made worse off, as they constitute the less attractive segment to the Firm.

5.6 Limitations of the Model

The model derived above is a simplified reflection of reality and therefore subject to some limitations. In order to isolate the effect of social preferences, the model abstracts away from any costs of production. These would alter the firms' incentives to provide quality and affect the price adjustment for stronger preferences.

Another limitation primarily concerns the structure of the markets. While Market 1 is only served by Firm A, Market 2 features a duopolistic structure. However, one could imagine that Firm B also has an incentive to enter the first market previously covered by Firm A only in order to sell some additional units of its product. Similarly, other firms could sell to these consumers, so that Firm A is faced with two different firms. The simplifying assumption regarding the differences in market structures ensures that differences in the

price-quality ratios can indeed arise³. Nevertheless, it does not address the question *why* this market structure exists and whether it is stable in the long run.

As noted above, the interaction between the two competitors is based on the assumption of two separate markets that are exogenously defined and of equal size. Each of the two markets consists of a unit mass of consumers. These simplifications might not always hold true in reality. This feature of the model could be altered if the size of Market 2 is assumed to be normalized to 1, whereas the size of Market 1 is measured by a parameter τ while keeping the distribution of the taste for quality γ fixed across markets⁴. In this case, Firm A's profit function would extend to:

$$\Pi^A = \tau p_1^A (1 - \theta') + p_2^A (1 - \theta^*) \quad (5.16)$$

With an increasing level of τ , this market segment becomes more important to Firm A which is likely to increase the price p_2^A and profits of both firms may rise. Nevertheless, this case would also neglect the fact that firms can often influence the size (and characteristics) of the different segments (for example the age under which children are granted a discount). It needs to be carefully considered how social preferences can be reasonably integrated into a model with an endogenous decision on market sizes. The current model may provide first insights that can be further extended by allowing firms to influence the sizes of consumer segments themselves.

³ If both markets were ex-ante symmetric in the sense that both firms sell in both segments, the prices and qualities chosen would be the same, eliminating any potential influence of social preferences.

⁴ That implies that the highest preference for quality is still the same in both market segments.

6

Discussion

Having analyzed and interpreted different game-theoretical models in a monopolistic and a competitive setting, the following section discusses the overall contributions and limitations of the models. Afterwards, several implications of the results are drawn for practitioners. Lastly, more general directions for future research in the areas of theoretical and empirical research are suggested.

6.1 Contributions to Research

The three models differ in their basic assumptions and structures. For that reason, they also make different contributions to the research on price discrimination, the impact of fairness concerns and the signaling (Section 3) or optimal choice (Section 5) of quality. The model presented in Section 3 examines the role of social preferences on the optimal price strategy and quality choice under asymmetric information. It has four major implications for the monopolist's price decision. *First*, contrarily to past research, both a high and a low price may constitute profitable signals of product quality in separating equilibria – depending on the level of costs. *Second*, it is the uncertainty of consumers about product quality that induces the low cost type to introduce low quality as well or to offer a second good in the first period. Under perfect information, the low cost monopolist would always decide to sell high quality only. *Third*, price discrimination is not identified as an optimal strategy for the monopolist in order to signal the true cost type. *Fourth*, the social comparison of consumers limits the feasibility of a price discrimination strategy based on self-selection.

Moreover, the comparative analysis demonstrates that consumers can benefit from smaller levels of low quality if the monopolist has low costs, reducing the price paid for the high quality product. If low quality is sufficiently small, the two types always separate in equilibrium and offer different product qualities (A sells high quality, whereas B sells low quality). That is, the ex-ante uncertainty is resolved when the products are sufficiently differentiated – regardless of the cost levels. In case of price discrimination, strong social preferences decrease the difference in prices and may increase the demand for high quality, while reducing the profit of the monopolist.

In a next step, the structure of this model is transferred to a duopoly, so that one competitor is assumed to have a cost advantage vis-a-vis the other one (see Section 4). For simplicity, the equilibria are derived only for the case of symmetric information, implying that consumers observe the quality before the purchase. Three conclusions regarding the optimal pricing strategy can be drawn. *First*, if both firms have the same level of costs, A sells high quality and B sells low quality, resulting in a high level of product differentiation and, consequently, a weaker price competition. *Second*, if A has a cost advantage, the firm's profit is maximized by offering both high and low quality in order to drive Firm B out of the market. *Third*, if price discrimination cannot be implemented, Firm A prefers to sell only high quality at a low price and to become the sole producer in the market. As long as Firm A has a cost advantage, it endogenously emerges as the monopolist in this game. The competitive effects induce the low cost firm to choose different strategies depending on the level of costs, as opposed to the monopoly model.

The model further shows that stronger social preferences can result in a higher or lower demand for the high quality product if Firm A price discriminates. This depends on the trade-off between a reduced willingness to pay and a lower price for high quality. In some cases, the price reduction may overcompensate the disutility from stronger social preferences and create a higher demand for the superior product.

The third model developed in Section 5 differs from the other two with respect to the degree of price discrimination and the scope of strategic decisions. Firm A serves two separate market segments (third-degree price discrimination), while Firm B only serves one segment. Both firms can choose their optimal levels of quality. The social preferences displayed by consumers in Market 1 who can only buy from Firm A have three key effects

on prices and qualities. *First*, strong social preferences in the monopolistic market decrease the price in this segment but increase the prices of both firms in the other one. In extreme cases, the price in the segment only served by Firm A might be below the price charged in the other segment despite the fact that qualities are the same and that in general a lower level of market power goes along with lower prices. *Second*, Firm B lowers its quality level if social concerns become more important to consumers. *Third*, social welfare rises for strongly concerned consumers. As far as the consumer surplus is concerned, the only segment that is worse off for higher levels of social preferences is the one buying high quality in the duopolistic market and being selfish.

Summing up, the three models analyze the role of social preferences when a firm considers whether to price discriminate among consumers in very different settings: A monopoly with quality uncertainty and two duopolies with perfect information and second or third-degree price discrimination. The first two models apply a similar approach in assuming exogenous qualities. The cost advantage of one type translates in different strategy options concerning the quality in the monopoly. The signaling model of Section 3 extends past research by providing one type with a decision on the quality levels, whereas past models have often assumed that a monopolist is either a high or a low quality producer. This assumption augments the strategic options of the monopolist and provides evidence that both types could offer a low quality product in equilibrium. In the duopolistic model (Section 4), the cost asymmetry has the further effect of enabling one firm to become a monopolist by setting a low price for the chosen product quality. Although it is neither an optimal separating strategy under quality uncertainty nor an equilibrium under perfect information for the monopoly, second-degree price discrimination yields the highest profit for a low cost competitor in a duopoly, given the asymmetry in variable costs. As a consequence, the price discrimination strategy drives a low quality producer out of the market, constituting the optimal choice for a low cost producer whenever feasible.

Contrary to the two models assuming exogenously given qualities, the model in Section 5 points out that strong social preferences can decrease the level of low quality offered in a duopolistic market, while leaving the levels of higher quality unaffected. The model enriches the insights obtained in the first two approaches and in past research (for example

Milgrom and Roberts (1986)) by highlighting the firm's endogenous choice to adjust their qualities as a response to increasing social preferences. The reduced complexity of the model further allows to precisely analyze the welfare implications of social preferences, revealing that the (mostly) positive change in consumer surplus and in the profit of Firm B offset the loss in profit of Firm A. The overall impact of stronger social preferences on social welfare is thus always positive.

6.2 Limitations of the Models

Any model is a simplification of reality, allowing researchers to focus on particular aspects of real-life decision making in more detail, while at the same time neglecting others. The models examined in Sections 3, 4 and 5 are based on specific assumptions. Four limitations that relate to at least two of the three models and alternative ways to reduce them will be discussed below. They concern the exogenous quality and linear costs in the first two models, as well as the consumer tastes for quality and the form of social preferences in all three models.

6.2.1 Exogenous Qualities

The first two models address the ex-ante uncertainty of consumers regarding the product quality and the competitive effects on the pricing strategy, respectively. For simplicity, both models assume that the product quality can take only two values, $q_h = 1$ and $q_l < 1$ and that the types differ in the range of quality they can offer. While this restriction is reasonable for the analysis of signaling games and thus has been used by a multitude of models in the past (see for instance Hoerger (1993)), it may not perfectly reflect the scope of decisions firms in reality have. In most of the cases, firms can determine the number of product variants and their respective quality levels on their own and by that the optimal strategic positioning.

In order to make the models more realistic, they could be extended by an endogenous quality selection in the first stage, as incorporated in the third model. After observing the levels of costs, the firms could then first decide on the optimal level of quality (or qualities, if two goods are offered) and then set their profit maximizing prices. The integration of quality choices would further enrich the model, as it would study the effect of information

asymmetries not only on prices but also on the levels of quality provided. Relative to the first-best case, the asymmetric distribution of information could result in quality distortions, as pointed out by Mussa and Rosen (1978) for example. Their analysis shows that a monopolist provides socially inefficient qualities to all consumers except for the ones with the highest taste for quality. Similar findings might be obtained in the setting of the two models developed in Sections 3 and 4.

6.2.2 Linear Costs

Another limitation that is common to the first two models relates to the cost function¹. The two types of firms do not only differ in the range of qualities they can provide but also in their variable costs: While A is assumed to have low costs c_A , B suffers from higher costs $c_B > c_A$. In both cases, costs are linear in qualities. That is, each additional unit of quality raises the costs to the same amount. This type of costs has been implemented in several other models before. Bagwell and Riordan (1991) and Hertzendorf (1993) assume linear costs, where the costs for high quality exceed those for low quality. This approach suggests that the firm incurs higher linear costs (for example c_H) for higher quality and lower linear costs ($c_L < c_H$) for low quality. It is a reasonable assumption in the scope of those models, since the monopolist is assumed to be either a high or a low quality producer. Nevertheless, in the context of the model presented in Section 3 this specific cost function would imply that both types are equally competitive because they incur the same level of costs for producing the same quality².

Another possibility to model costs is to assume them to be quadratic in quality, see for instance Gal-Or (1989). In this case, a higher quality leads to an over-proportional increase in costs. How would this assumption alter the results? On that account, the monopoly model is considered as an example. When comparing the profit of A from selling quality q_j at price $p_{q_j}^A$ under first best, the function would change from

¹ The third model abstracts from any costs, but could also be extended by quadratic costs of quality.

² The assumption that the costs of low quality additionally differ across the two types could make the analysis too complex.

$$\begin{aligned}\Pi_{q_j}^A &= 2 \left(p_{q_j}^A - c_A q_j \right) \left(1 - \frac{p_{q_j}^A}{q_j} \right) \\ \Pi_{q_j}^A \left(p_{q_j}^{A*} \right) &= \frac{(1 - c_A)^2 q_j}{2}\end{aligned}\tag{6.1}$$

to the profit function:

$$\begin{aligned}\Pi_{q_j}^A &= 2 \left(p_{q_j}^A - c_A q_j^2 \right) \left(1 - \frac{p_{q_j}^A}{q_j} \right) \\ \Pi_{q_j}^A \left(p_{q_j}^{A*} \right) &= \frac{(1 - c_A q_j)^2 q_j}{2}\end{aligned}\tag{6.2}$$

If A sells high quality, the profits remain the same. The provision of low quality, however, becomes more attractive relative to high quality under quadratic costs. The resulting profits from selling high and low quality are:

$$\begin{aligned}\Pi_{q_h}^A &= \frac{(1 - c_A)^2}{2} \\ \Pi_{q_l}^A &= \frac{(1 - c_A q_l)^2 q_l}{2}\end{aligned}\tag{6.3}$$

More importantly, the price discrimination strategy becomes more attractive due to the cost advantage from selling low quality to some consumers. Under perfect information, the optimal price and discount would be reflected by the following expressions:

$$\begin{aligned}p_{PD} &= \frac{4(1 + c_A) q_l + q_l (4 + c_A (3 + q_l)) \gamma - c_A (1 - q_l^2) \gamma^2}{-\gamma^2 + q_l (8 + \gamma (8 + \gamma))} \\ \delta_{PD} &= \frac{q_l (2\gamma - c_A \gamma (2 + \gamma) + c_A q_l^2 (1 + \gamma) (4 + \gamma) + q_l (4 + (2 + c_A) \gamma))}{4(1 + c_A) q_l + q_l (4 + c_A (3 + q_l)) \gamma - c_A (1 - q_l^2) \gamma^2}\end{aligned}\tag{6.4}$$

These optimal choices would induce positive consumer demands, as opposed to the first-best choices under linear costs. The profit for type A is given by:

$$\Pi_{PD}^A = \frac{2q_l(1+\gamma)(2 - c_A(4 + \gamma - q_l\gamma - c_A(1 + q_l)(2 - q_l + (1 - q_l)\gamma)))}{-\gamma^2 + q_l(8 + \gamma(8 + \gamma))} \quad (6.5)$$

This profit is even higher than the first-best profit from selling high quality only ($\Pi_{PD}^A > \Pi_{q_h}^A$). Linear costs induce the low cost monopolist to sell only one good in the first best case. Quadratic costs, contrarily, provide sufficient incentives to offer a second good at relatively lower costs.

Despite the fact that quadratic costs might be more realistic for some goods, they also significantly increase the complexity of the analysis. For that reason, a game theoretical model needs to balance the tractability of results and the appropriateness of assumptions.

6.2.3 Consumer Preferences for Quality and Market Size

All of the three models developed throughout the thesis assume that consumers are heterogeneous in their valuations of quality. While some attach a higher weight to product quality, others care less about it. The individual preference for quality is measured by the parameter θ which is uniformly distributed in the interval $\theta \in [0, 1]$. A firm must choose an optimal price that balances two effects: A lower price induces more consumers with a lower θ to purchase an item. However, the reduced price decreases the profit margin of the firm. If a firm price discriminates and offers two goods, a reduction in the price for the low quality good additionally extends the cannibalization problem – if the price for a low quality good falls, more consumers will decide to buy the cheap rather than the expensive good.

The assumption that θ takes on values between zero and one leads to the inherent characteristic of the model that the market is uncovered in equilibrium. Consumers with a very low preference for quality are willing to pay only a very low price for the good. As a result, a firm finds it optimal to sell only to some consumers, while those individuals with the lowest levels of θ do not find it reasonable to purchase an item. The assumption of $\theta \in [0, 1]$ could for instance be relaxed by assuming a lower bound $\underline{\theta} > 0$ and an upper bound $\bar{\theta}$, where $\bar{\theta} = \underline{\theta} + 1$. This could allow for covered markets in which all consumers can buy from the firms and enable the analysis of optimal strategies with respect to the

distribution of consumer preferences for quality³. Additionally, if $\bar{\theta} \neq \underline{\theta} + 1$, the role of the overall market size can be further assessed. These modifications can be applied to all of the three models.

6.2.4 Disadvantageous Inequity Aversion

When consumers in these models are offered two goods at different prices, they exhibit social preferences in the form of disadvantageous inequity aversion. Consumers paying the higher price per quality experience a disutility resulting from the social comparison with other consumers. Past research has provided a lot of evidence for the role of social preferences in individual decision making and for the prevalence of inequity aversion (Fehr and Fischbacher (2002)).

However, consumers do not only care about being worse off than others. Some of them also might derive utility from paying the lower relative price, a phenomenon referred to as “smart-shopper hypothesis” in research (see Darke and Dahl (2003)). How would this change the utility functions of consumers? Once more, the first model introduced in Section 3 is used as an example. In the case where A and B pool in prices in equilibrium, the expected utilities of consumers would then be reflected by the following two functions:

$$\begin{aligned} Eu_H &= \theta m - p - \gamma \left(\frac{p}{m} - \frac{\delta p}{q_l} \right) \\ Eu_L &= \theta q_l - \delta p + \alpha \left(\frac{p}{m} - \frac{\delta p}{q_l} \right) \end{aligned} \tag{6.6}$$

Accordingly, the marginal consumers who are indifferent between buying the expensive or the cheap good (θ^*) and between purchasing the low quality or nothing (θ^L) are given by:

$$\begin{aligned} \theta^* &= \frac{p(1-\delta)}{m-q_l} + \frac{(\alpha+\gamma)p(q_l-\delta m)}{mq_l(m-q_l)} \\ \theta^L &= \frac{\delta p}{q_l} - \frac{\alpha p(q_l-\delta m)}{mq_l^2} \end{aligned} \tag{6.7}$$

Being faced with “smart shoppers” and inequity averse customers, the monopolist needs

³ See for instance Wauthy (1996).

to balance the positive and negative effects of a price discrimination strategy on the utility of consumers. The qualitative results of the analysis for $\alpha > 0$ remain relatively similar to the ones derived in Section 3 with $\alpha = 0$. The simplified version of the social preferences has been used in order to keep the analysis more tractable. Similar modifications can be made for the other two models.

In addition to that, consumers could display other forms of preferences than the one explained above. If consumers are generally averse against unequal outcomes, both segments would suffer from the quality-based price discrimination⁴. Which implications the social comparisons have for consumer utility – and consequently which form of social preferences is “the most adequate one” for a theoretical model – might depend on the context of the interaction between firm and consumers, such as the type of product or the availability of information to consumers.

6.3 Managerial Implications

The models derived above can be applied to a multitude of settings and thereby yield universal insights relevant for researchers and practitioners in many fields. A price discrimination strategy can be implemented in almost any industry, such as restaurants, fashion stores or consulting services. One area in which practitioners might show particular interest about the contributions of the dissertation project is the role of paid content and paid services in online business. Paid content and paid services describe business models in which customers pay for the use of digital content online, such as news magazines where some articles are subject to a charge⁵. In these online businesses, the fraction of marginal costs per consumer are comparably low – be it online news magazines or the provision of software. Managers need to trade off two objectives: Attracting further consumers with a cheap (or costless) offer while at the same time yielding positive profits with a more advanced service (implying a higher quality). Consumers might perceive a price for articles unfair relative to the limited offer free of charge, especially if they are not able to judge the quality of the premium articles ex-ante. The firm’s price thus needs to balance the consumer preferences, the signaling of information and the profitability. Little research has

⁴ This would imply that $\alpha = \gamma$ in Equation 6.6.

⁵ For more information on paid content and paid services, see Stahl (2015).

been conducted on the perceived fairness of paying for these contents or services and the firms' optimal strategies. The models developed in Sections 3, 4 and 5 might thus provide a first indication on the implications of offering different variants at different prices.

Furthermore, the models also shed a new light on the three examples presented in the introduction. In the case of Allianz Global Investors, individuals were upset that they are asked to pay a performance-based fee for investing their money. This can be explained by the fact that they need to pay higher fees for higher performances of the product. Translating the performance of the investment fund into the "quality"⁶, the models predict that the comparison with other products, such as the Exchange Traded Funds free of charge, reduces their utility and thus their willingness to pay – except for the case in which the higher costs for the fund are more than offset by the higher performance compared to the benchmark (so that individuals yield a higher total return from the investment fund than from the benchmark). A fixed fee might therefore be more reasonable for those investment funds that are not likely to exceed the performance of the benchmark by far.

Additional insights on the second example are also obtained through the analysis of social preferences and price discrimination. The case of Media-Markt addressed the differences in prices for particular items in their online and brick-and-mortar stores. Consumers can easily compare the prices in their local store and the online shop by using their smart phones. The multichannel strategy of Media-Markt therefore carries a substantial risk: Consumers may become increasingly aware of potential price differences and compare the prices in the local store during their visit with those charged in the internet. Even though they consult the service staff in the bricks and mortar store, they already know that they will only purchase the item online – at Media-Markt or another competitor – at a more attractive price. The pricing strategy does not only invite consumers to pay more attention to price differences, it could also harm the satisfaction and loyalty of consumers and thus may result in long run disadvantages for the company.

How do the models relate to the third case about the ExtraKarte introduced by Kaiser's Tengelmann? It provides a good example of how a price discrimination strategy can be implemented without making customers too angry or disappointed for three reasons. *First*, the ExtraKarte is only based on the purchase behavior and does not contain any personal

⁶ Note that in this case, even the firms are uncertain about the realized quality of their product ex-ante and the final price is determined only after the performance has been measured.

information, such as age, address or gender. This provides consumers with an adequate scope of privacy, while at the same time using a lot of data to customize the offers⁷. *Second*, the ExtraKarte offers individual *discounts* for different products to consumers. If a consumer does not receive a discount for a particular item, it is likely that he does not automatically perceive this as “paying a higher price for the same quality” but as “paying a regular price”. That is, the price differences are adequately communicated to consumers. *Third*, since discounts are individualized and printed out on a coupon, the comparability across consumers is relatively low. Shoppers cannot observe whether another customer receives the same discount or not, decreasing the similarity of transactions. By that, the influence of social comparisons on the willingness to pay and customer satisfaction is limited. For these reasons, the pricing strategy of Kaiser’s Tengelmann constitutes a benchmark case for other firms which consider to implement a price discrimination strategy but fear the potential negative reactions of consumers.

In addition to these three examples, the models aid practitioners to improve their pricing strategy in more concrete terms. They underline the strategic impact of a firm’s pricing strategy which goes beyond the optimal trade-off between an increased profitability and a decreased consumer demand in two different dimensions. On the one hand, firms need to account for the information the price conveys to consumers about the underlying cost type and the true quality level offered, making the price decision even more complex. This requires the detailed analysis of both the buyer and seller side of the market: The characteristics, expectations, preferences and available information of consumers as well as the cost levels and quality options of other firms.

These considerations are especially relevant for launching new goods where quality is unknown to consumers. If a firm introduces a completely new product on a market (such as a new technology or a new restaurant)⁸ it cannot build on the reputation established with the performance of former products, such as suggested by models of umbrella branding (Andersson (2002)). Instead, it needs to convince consumers to try out the new good with

⁷ Rossi et al. (1996) already point out that the use of purchase behavior significantly increases the profitability of price discrimination.

⁸ When it comes to the launch of innovations, the model in Section 3 is particularly helpful, since it captures the fact that the firm has monopoly power and consumers cannot draw on the recommendations of others so as to better assess the quality of the innovative product.

the help of different instruments. As far as the price as a signal of product quality is concerned, the monopolistic model in Section 3 recommends managers to consider both the high and the low price strategy when high quality is produced.

On the other hand, the firm's pricing strategy further influences the consumer behavior through non-economic components. The models address the topic of disadvantageous inequity aversion as one specific form of social preferences. Which implications can be derived about their role for firm strategies? A first intuitive recommendation could be to "account for consumers' disutility from paying a higher price" when deciding on the optimal pricing. Nevertheless, this advice would be neither helpful nor sufficient to grasp the full magnitude of the decision problem.

Instead, firms need to consider various aspects, so as to avoid losses in profits due to negative consumer responses. It is therefore reasonable to formulate some more specific recommendations for firms regarding the role of social preferences for their pricing strategy. If a firm wants to implement a price discrimination strategy, the following steps need to be considered:

- What are the individual preferences of (potential) customers?
- Which information do consumers have and use to evaluate the price fairness?
- What are the *behavioral* consequences of the targeted and subsequent consumers who perceive a price or transaction as (un)fair?
- How can the consumers be aggregated to segments?
- What is the potential improvement in profits from discriminating among consumers?
- What are the effects of price discrimination on the behavior of competitors?
- How can the transactions with consumers become more differentiated so as to decrease their comparability from the consumers' perspective?
- What is the optimal trade-off between increased profit margin and decreased consumer utility?

These questions will aid practitioners in defining the optimal pricing strategy which does not only look at the incremental profit from exploiting consumer heterogeneity but

also accounts for the consequences of a perceived unfairness on an individual consumer and a competitive level.

6.4 Directions for Future Research

The models presented in Sections 3, 4 and 5 extend the current research by integrating non-economic components into the utility function of individuals and, as far as the monopoly is concerned, examining the role of quality uncertainty for optimal pricing decisions. Yet there are several fields in which more empirical and theoretical research is needed in order to deepen the understanding of social preferences and quality uncertainty as well as their effects on consumer and firm behavior. Several suggestions for research in the areas of product characteristics (in particular, quality uncertainty), firm strategies and consumer characteristics are made in the following.

6.4.1 Product Characteristics

In general, the framework of the model featuring quality uncertainty might also be transferred to other areas. One could consider the case in which a firm wants to conduct a project, for example the analysis of production processes, and for that purpose wants to engage a consultant. However, there might be uncertainty about the consultant's (or agent's) true abilities. An agent with a high ability has lower costs of effort relative to one with lower abilities. The effort level exerted by the agent then translates into some output. While the firm (or principal) cannot observe the true input level, it does observe the final output of the project. In this scenario, a high ability agent can offer a thorough analysis ("high quality project") and a basic analysis ("low quality"), while a low ability agent is only able to provide a basic service to the principal. If the principal can choose whether to perform a more expensive or a cheaper project, he might compare the prices and expected qualities of the two and account for the differences in price-quality ratios.

Similar to the framework considered in Section 3, a highly skilled agent might want to signal the potential quality of its work to the principal and separate from a low ability worker. Moreover, a high ability worker needs to optimize the spread in the price for the two types of projects but at the same time consider the emotional effects of the price spread on the principal, captured by the social preferences. By that, game-theoretical research

could investigate how social preferences influence the optimal prices and the effort choices of the agent in the context of moral hazard. This would extend the current model by embedding it into a different context and by incorporating an incentive effect: The price paid by the principal induces the agent to choose a particular effort level, so that the principal can exert some influence on the level of quality provided. This interactive effect as well as the translation of efforts into some quality level constitute interesting extensions of the model for future research.

6.4.2 Firm Strategies

While most of the research on social preferences has focused on the behavior of consumers, the implications for firms and their adaptations in optimal strategies need to be emphasized as well. Future research should therefore also take a closer look at the optimal behavior of firms with respect to the integration of social preferences and the influence on price discrimination strategies.

On the one hand, empirical research could analyze to what extent firms are aware of and account for the social preferences of their (potential) customers especially in their pricing decisions. How does the feeling of “getting more for the money” impact the firm’s decision on the optimal prices, the optimal quality levels of the goods and finally the signaling or concealing of true differences between qualities? How does the inequity aversion alter the desire of the firm to exploit the heterogeneity among consumers’ willingness to pay in practice? While many restaurants or hotels have issued coupons on websites (such as www.groupon.com) so as to invite more potential customers and make their business more popular, many of them have experienced negative consumer reactions and afterwards refrain from selling coupons again. If the pricing schedule of the firm is actually affected by the social preferences of customers, it is crucial to find out whether firms have experienced negative reactions due to the perceived price unfairness already, whether they conduct market research in order to learn more about the preferences of their consumers or – this might rather hold for smaller firms – whether they find it unfair themselves to discriminate among consumers and thus disregard price discrimination strategies.

On the other hand, further studies of quality-based price discrimination in particular could shed light on the circumstances under which firms try to hide or reveal the true

differences in the qualities of the goods and how they communicate them to consumers as a response to social preferences. From a game-theoretical perspective, future research could aim at comparing the profitability of different forms of price discrimination under the assumption of socially concerned consumers. Moreover, the second model presented in Section 4 could be analyzed with an asymmetric distribution of information, examining the effects of competition and social preferences on the quality signaling and optimal pricing strategies of firms.

6.4.3 Consumer Characteristics

Despite the fact that deviations from the behavior suggested by standard economic theory have been observed for a long time in experiments, research still lacks adequate models that analyze the underlying reasons and implications from a more theoretical perspective.

Substantial research is needed aiming at the observation of social preferences in real-life situations. While laboratory experiments are convincing due to their focus on specific influencing factors, the results are limited with respect to their external validity. Additionally, findings from laboratory experiments explain the behavior of an individual in one particular situation. Whether the experimental results correctly predict the influence of social preferences in other situations is not yet studied in detail and remains a topic for future research. For these reasons, the forms and interactions of social preferences should be studied in real situations, such as consumers' purchase decisions. The findings could underline the prevalence of social preferences and specify the insights yet obtained – and thus provide a more precise direction for empirical and theoretical research on the subject.

In the area of consumer psychology and price fairness, empirical research has concentrated on the role of past prices or reference prices suggested by the seller. An interesting field could be the comparison of products with different qualities sold at different prices from the consumers' perspective. Which conditions favor the comparison of prices and expected qualities? How do these comparisons modify the purchase intention, willingness to pay and overall satisfaction of consumers?

When integrating social preferences into game-theoretical models, researchers need to be cautious for two reasons. On the one hand, the attempt to make models more realistic by including consumer heterogeneity or other regarding preferences can increase the com-

plexity of the analysis significantly. On the other hand, it should be carefully examined whether the framework of the model is appropriate and meaningful for the modification of utility functions. Otherwise, the interpretation and practical implications of the theoretical findings might turn out less relevant.

Summing up the suggestions for future research, it should be clear that various topics deserve closer attention from theoretical, experimental and empirical research: The influencing factors of social preferences and their prevalence in different real-life decision situations, the optimal responses of firms to the non-economic components of customer behavior, the implementation of price discrimination strategies in practice, the role of asymmetric information on pricing strategies in competitive settings and the endogenous quality choice in a signaling game.

Conclusion

Three different examples were discussed in the introduction to this thesis. They all addressed the influence of social preferences on consumers' perception of fairness in a transaction. The variety of consumer reactions illustrated the consequences of different pricing strategies. The observation that customers consider more than the performance of a product and the price paid for it when evaluating a purchase transaction has also been supported by past research. Consumers tend to account for non-economic components, such as friendliness, service quality or price fairness. One particular form of social preferences is the aversion against inequitable outcomes. The thesis has concentrated on the comparison of price-quality ratios among consumers, that is, their tendency to compare the different prices charged per unit of quality. If an individual pays a higher price for the same quality, for instance, the corresponding utility from the transaction and the willingness to pay is reduced.

Consumers often attempt to reach fair outcomes. These social preferences, however, may oppose the firms' strategies, especially their desire to maximize profits by differentiating prices that depend on each consumer's willingness to pay. The so-called price discrimination is given when the difference in prices does not solely reflect the difference in marginal costs. It can be utilized in different ways, such as the quality-based one further analyzed throughout the thesis.

The technological development further intensifies the potential conflict of both parties' interests. Consumers can now easily compare prices across firms, other customers or lo-

cations with the help of various portals, increasing the transparency for consumers. They have become more aware of and sensitive to price differences. As a consequence, they report their dissatisfaction with a transaction perceived as unfair and are further willing to take actions that decrease their utility in order to vent their anger. At the same time, firms have now access to crucial data about their (potential) customers and are able to evaluate the data at relatively low cost.

The key question in this context is therefore: What is the optimal level of price discrimination, when consumers are averse against differences in the price-quality ratios? While some firms have not yet successfully resolved this trade-off without negative publicity, such as Media-Markt, others have developed strategies that live up to the expectations of both sides (for example Kaiser's Tengelmann). Another concern for the implementation of a price discrimination strategy is the distribution of information. Is a second-degree price discrimination the optimal strategy when a firm sells experience goods whose quality consumers cannot assess before the purchase?

The analysis of the literature in Section 2 has summarized and critically assessed the contributions of past research on the topics of product characteristics, firm strategies and consumer characteristics. Empirical, experimental and theoretical studies have been discussed. As far as the social preferences are concerned, substantial progress has been made with respect to laboratory experiments. However, the prevalence of different forms of preferences and their interaction in real-life needs to be further analyzed in the future. Additionally, the incorporation of social preferences into the context of specific pricing strategies deserves more attention from theoretical research. Theoretical models on quality uncertainty have often disregarded the quality choices of firms which are important drivers for the optimal pricing strategies.

The questions formulated in the beginning and the gaps identified in the current state of research have been addressed with the help of three game-theoretical models which differ in the degree of competition, the form of price discrimination and the distribution of information. The first model added the dimension of quality uncertainty to a monopoly with socially concerned consumers. It analyzed the role of the price as a quality signal and the conditions under which a second-degree price discrimination constitutes an optimal

strategy in equilibrium. The second model translated the first one into a competitive setting, where two firms with asymmetric costs compete in prices under perfect information. The third model concentrated on a third-degree price discrimination in a duopoly, where both firms are symmetric in costs and endogenously decide on their optimal levels of quality, by that concentrating on the aspect neglected by the first two games.

The three models provide interesting insights on the role of social preferences and the application of a price discrimination strategy. While discriminating among consumers does not constitute an optimal separating strategy for a low cost type, it offers an attractive alternative to pool with a high cost one in a monopoly (Section 3). For strong social preferences, the difference in prices is reduced, as shown in the comparative analysis. Moreover, it provides a low cost firm with the highest profit in order to eliminate the competition under perfect information (Section 4). As far as the second-degree price discrimination is concerned, the social preferences limit the implementation to the extent that positive demands for both goods are only induced for particular levels of prices and discounts. That is, stronger concerns for the price-quality ratio of others result in smaller ranges of costs for which price discrimination is feasible. The third model finds that social preferences lead to adjustments in prices for all segments and a downwards distortion of the lower quality in the segment served by both firms. In this case, consumer surplus may rise, while social welfare always increases in social preferences.

The specific discussions in Sections 4.7 and 5.6 as well as the overall discussion in Section 6 further pointed out the limitations and potential extensions of the models. Several suggestions on how to overcome these limitations have been made as well. In addition to that, specific implications for managers have been proposed. Faced with an asymmetric distribution of information, they should consider both low and high prices so as to signal their high quality. With regard to social preferences, the importance of “knowing the (potential) customers”, the role of information and the differentiation of transactions which leads to a lower comparability have been pointed out. In order to do so, managers first need to put themselves into the shoes of consumers in order to anticipate their – possibly diverse – reactions to particular pricing strategies.

Overall, the thesis brings together very different streams of research and integrates

them into comprehensive models that focus on particular aspects of transactions between socially concerned consumers and profit maximizing firms. These models are somewhat abstract which allows the application to many situations. By that, they contribute to further deepen the understanding of the consequences of social preferences on the behavior of consumers and, in turn, the optimal strategies of firms.

Appendix

8.1 Monopoly with Quality Uncertainty

8.1.1 Social Preferences and Price Discrimination

If the low value segment pays the higher price per quality, the expected utilities are given by:

$$\begin{aligned} Eu_h &= \theta q_h - p \\ Eu_l &= \theta q_l - \delta p - \gamma \left(\frac{\delta p}{q_l} - \frac{p}{q_h} \right) \end{aligned} \tag{8.1}$$

The marginal consumer who is indifferent between buying high quality and buying low quality is given by θ^* , while the marginal consumer who still purchases the low quality is given by θ^L :

$$\begin{aligned} \theta^* &= \frac{p((1-\delta)q_h q_l + \gamma(q_l - \delta q_h))}{q_h q_l (q_h - q_l)} \\ \theta^L &= \frac{p(\gamma(\delta q_h - q_l) + \delta q_h q_l)}{q_h q_l^2} \end{aligned} \tag{8.2}$$

There is no positive demand for low quality, since $\theta^* < \theta^L$:

$$\theta^* - \theta^L = -\frac{p(q_l + \gamma)(q_h \delta - q_l)}{(q_h - q_l)q_l^2} < 0 \quad (8.3)$$

Q.E.D.

8.1.2 Proof of Proposition 1

The profit function and optimal price of a high cost monopolist are:

$$\begin{aligned} \Pi_{q_l}^B &= 2(p - c_B q_l) \left(1 - \frac{p}{q_l}\right) \\ p_{q_l}^B &= \frac{(1 + c_B)q_l}{2} \\ \Pi_{q_l}^B &= \frac{(1 - c_B)^2 q_l}{2} \end{aligned} \quad (8.4)$$

A low cost monopolist can either sell high quality, low quality or both quality levels (price discrimination). In the first case, the optimal price and profit are:

$$\begin{aligned} \Pi_{q_h}^A &= 2(p - c_A)(1 - p) \\ p_{q_h}^A &= \frac{1 + c_A}{2} \\ \Pi_{q_h}^A &= \frac{(1 - c_A)^2}{2} \end{aligned} \quad (8.5)$$

If A sells low quality, its profit is:

$$\begin{aligned} \Pi_{q_l}^A &= 2(p - c_A q_l) \left(1 - \frac{p}{q_l}\right) \\ p_{q_l}^A &= \frac{(1 + c_A)q_l}{2} \\ \Pi_{q_l}^A &= \frac{(1 - c_A)^2 q_l}{2} \end{aligned} \quad (8.6)$$

If A sells both high and low quality, the expected utility functions of consumers are:

$$\begin{aligned}
Eu_h &= \theta - p - \gamma \left(p - \frac{\delta p}{q_L} \right) \\
Eu_l &= \theta q_L - \delta p
\end{aligned} \tag{8.7}$$

The consumer who is indifferent between the high quality good at price p and buying the low quality at a reduced price δp is given by θ^* , while the marginal consumer who still buys is given by θ^L :

$$\begin{aligned}
\theta^* &= \frac{p((\gamma + 1)q_l - \delta(\gamma + q_l))}{(1 - q_l)q_l} \\
\theta^L &= \frac{\delta p}{q_l}
\end{aligned} \tag{8.8}$$

The profit function of A is therefore:

$$\Pi_{PD}^A = (p - c_A)(1 - \theta^*) + (\delta p - c_A q_L)(\theta^* - \theta^L) + (p - c_A)(1 - p) \tag{8.9}$$

Lagrange optimization yields no results in which both products receive a positive demand, so that price discrimination is not applied under full information.

Since $\Pi_{q_h}^A \geq \Pi_{q_l}^A$, A always sells high quality under full information.

Q.E.D.

8.1.3 Proof of Proposition 2

A separating equilibrium with the first-best prices exists under quality uncertainty, if B has no incentive to imitate A. In this case, B sets the same price $p = p_{q_h}^A$ and consumers expect high quality with certainty. The profit of B is then given by:

$$\begin{aligned}
\Pi^B(p_{q_h}^A) &= (p - c_B q_l) \left(1 - p + 1 - \frac{p}{q_l} \right) \\
&= \frac{((3 - c_A)q_l - 1 - c_A)(1 + c_A - 2c_B q_l)}{4q_l}
\end{aligned} \tag{8.10}$$

B makes a higher profit from imitating this price than revealing its low quality for $c_A^* < c_A < c_A^{**}$:

$$\begin{aligned}
c_A^* &= \frac{q_l (1 + c_B + c_B q_l) - 1 - \sqrt{(1 - q_l) q_l^2 (2 - c_B^2 (1 + q_l))}}{1 + q_l} \\
c_A^{**} &= \frac{q_l (1 + c_B + c_B q_l) - 1 + \sqrt{(1 - q_l) q_l^2 (2 - c_B^2 (1 + q_l))}}{1 + q_l}
\end{aligned} \tag{8.11}$$

The full information equilibrium survives even under quality uncertainty for $c_A \in [0, c_A^*]$ and $c_A \in [c_A^{**}, c_B]$.

Q.E.D.

8.1.4 Proof of Proposition 3

If A wants to sell high quality and provide no incentive for B to imitate this price, the maximization problem of A is:

$$\begin{aligned}
\max_{p^*} & 2(p^* - c_A)(1 - p^*) \\
\text{s. t. } & \Pi_{q_l}^B \geq \Pi_{q_l}^B(p^*)
\end{aligned} \tag{8.12}$$

Except for the full information price which B wants to imitate for some parameter range (as shown above), the Lagrange optimization yields two results for which B is indifferent between imitating A and revealing its low quality:

$$\begin{aligned}
p_{S1}^A &= \frac{1 + c_A^*}{2} = \frac{q_l (2 + c_B + c_B q_l) - \sqrt{(1 - q_l) q_l^2 (2 - c_B^2 (1 + q_l))}}{2(1 + q_l)} \\
p_{S2}^A &= \frac{1 + c_A^{**}}{2} = \frac{q_l (2 + c_B + c_B q_l) + \sqrt{(1 - q_l) q_l^2 (2 - c_B^2 (1 + q_l))}}{2(1 + q_l)}
\end{aligned} \tag{8.13}$$

A makes the following profits:

$$\begin{aligned}
\Pi_{S1}^A &= \frac{2 - c_B q_l (1 + q_l) + \sqrt{(1 - q_l) q_l^2 (2 - c_B^2 (1 + q_l))}}{2(1 + q_l)^2} \\
&\quad \cdot [q_l (2 + (1 + q_l) c_B) - \sqrt{(1 - q_l) q_l^2 (2 - c_B^2 (1 + q_l))} - 2c_A (1 + q_l)] \\
\Pi_{S2}^A &= \frac{2 - c_B q_l (1 + q_l) - \sqrt{(1 - q_l) q_l^2 (2 - c_B^2 (1 + q_l))}}{2(1 + q_l)^2} \\
&\quad \cdot [q_l (2 + (1 + q_l) c_B) + \sqrt{(1 - q_l) q_l^2 (2 - c_B^2 (1 + q_l))} - 2c_A (1 + q_l)]
\end{aligned} \tag{8.14}$$

For $c_A < c_A^c$, A makes a higher profit with $p = p_{S1}^A$, while for $c_A > c_A^c$ the profit with $p = p_{S2}^A$ is higher:

$$c_A^c = \frac{q_l (1 + c_B + c_B q_l) - 1}{1 + q_l} \tag{8.15}$$

In a separating equilibrium, A may have no incentive to deviate to a low quality:

$$\begin{aligned}
\Pi_{q_l}^A &\leq \Pi_{S1}^A \\
\Pi_{q_l}^A &\leq \Pi_{S2}^A
\end{aligned} \tag{8.16}$$

The first equation is solved by c_A^1 and c_A^2 :

$$\begin{aligned}
c_A^1 &= \frac{c_A^* - 1 + q_l}{q_l} \\
&\quad - \frac{1}{A} \sqrt{\left(\left(2(1 + q_l)^2 (c_A^* - 1 + q_l) \right)^2 - 2A (c_A^* - 1 + q_l) (1 + q_l)^2 \right)} \\
c_A^2 &= \frac{c_A^* - 1 + q_l}{q_l} \\
&\quad + \frac{1}{A} \sqrt{\left(\left(2(1 + q_l)^2 (c_A^* - 1 + q_l) \right)^2 - 2A (c_A^* - 1 + q_l) (1 + q_l)^2 \right)}
\end{aligned} \tag{8.17}$$

with $A = 2q_l (1 + q_l)^2$

For $c_A^1 < c_A < c_A^2$, A has no incentive to deviate from its signaling strategy with $p = p_{S1}^A$. Moreover, $c_A^1 < c_A^*$: The first term of c_A^1 is already smaller than c_A^* , so that $c_A^1 < c_A^*$:

$$\begin{aligned}
c_A^* - \frac{c_A^* - 1 + ql}{ql} &= -\frac{(1 - c_A^*)(1 - ql)}{ql} \\
&= -\frac{(1 - ql) \cdot \left(2 - c_B ql(1 + ql) + \sqrt{(1 - ql) q_l^2 (2 - c_B^2 (1 + ql))}\right)}{ql(1 + ql)} < 0
\end{aligned} \tag{8.18}$$

A separating equilibrium with $p = p_{S1}^A$ exists for $c_A \in [c_A^*, \min(c_A^2, c_A^c)]$.

The second equation ($\Pi_{ql}^A \leq \Pi_{S2}^A$) is solved by the critical values c_A^3 and c_A^4 :

$$\begin{aligned}
c_A^3 &= \frac{c_A^{**} - 1 + ql}{ql} \\
&\quad - \frac{1}{A} \sqrt{\left(\left(2(1 + ql)^2 (c_A^{**} - 1 + ql)\right)^2 - 2A (c_A^{**} - 1 + ql) (1 + ql)^2\right)} \\
c_A^4 &= \frac{c_A^{**} - 1 + ql}{ql} \\
&\quad + \frac{1}{A} \sqrt{\left(\left(2(1 + ql)^2 (c_A^{**} - 1 + ql)\right)^2 - 2A (c_A^{**} - 1 + ql) (1 + ql)^2\right)}
\end{aligned} \tag{8.19}$$

For $c_A^3 < c_A < c_A^4$, A has no incentive to deviate from the high quality strategy. A plot of the two critical values c_A^4 and c_A^{**} reveals that $c_A^{**} < c_A^4$ (see Figure 8.1). That implies that the separating equilibrium exists for $c_A \in (\min(c_A^c, c_A^3), c_A^{**})$.

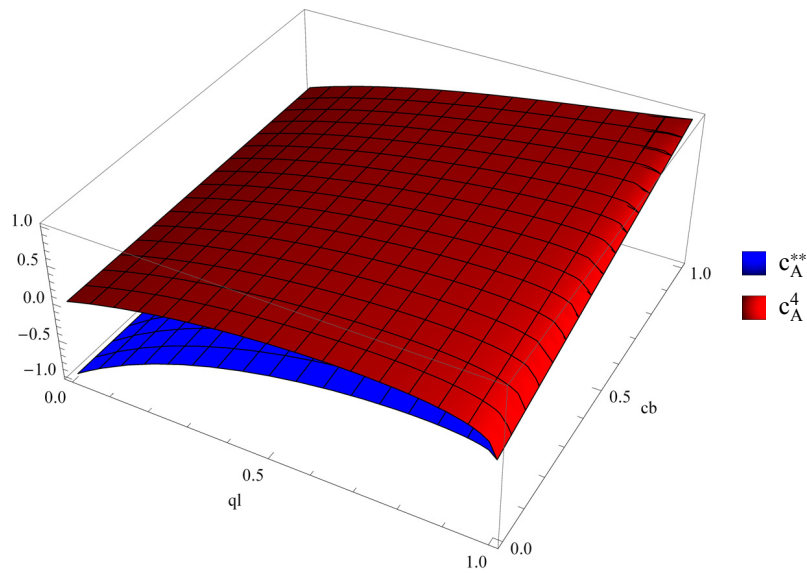


Fig. 8.1: Comparison of Critical Values c_A^{**} and c_A^4

Q.E.D.

8.1.5 Proof of Proposition 4

The proof of this proposition results from the proof above. Since $c_A^1 < c_A^*$ and $c_A^4 > c_A^{**}$, a separating equilibrium in which both firms sell low quality can only exist for $c_A^2 < c_A < c_A^3$. The requirement that $c_A^* < c_A < c_A^{**}$ is always fulfilled, since $c_A^2 > c_A^*$ and $c_A^3 < c_A^{**}$ (see Figure 8.2).

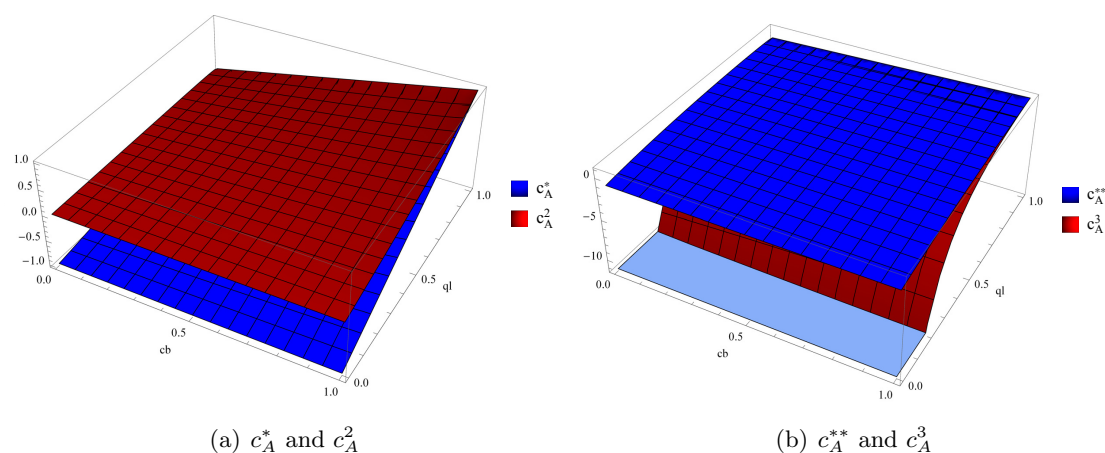


Fig. 8.2: Comparison of Critical Values c_A^{**}, c_A^2, c_A^3

Q.E.D.

8.1.6 Proof of Proposition 5

If both types set the same price and discount, consumers do not know which quality the expensive good has. The expected utilities are:

$$Eu_H = \theta m - p - \gamma \left(\frac{p}{m} - \frac{\delta p}{ql} \right) \quad (8.20)$$

$$Eu_L = \theta ql - \delta p$$

The marginal consumer who is indifferent between entering the low value segment and entering the high value segment in the first period is reflected by θ^* . In similar vein, the consumer who is indifferent between buying the cheap good and not buying at all is represented by θ^L :

$$\begin{aligned}\theta^* &= \frac{p(mq_l(1-\delta) + \gamma(q_l - m\delta))}{m(m-q_l)q_l} = \frac{p(1-\delta)}{m-q_l} + \frac{\gamma p(q_l - \delta m)}{m(m-q_l)q_l} \\ \theta^L &= \frac{\delta p}{q_l}\end{aligned}\quad (8.21)$$

A positive demand for the low quality good requires $\delta < \frac{q_l}{m}$:

$$\theta^* - \theta^L = (q_l - \delta m) \frac{p(m + \gamma)}{m(m - q_l)q_l} \quad (8.22)$$

The profit function of A is given by:

$$\Pi_{PD}^A = (p - c_A)(1 - \theta^*) + (\delta p - c_A q_l)(\theta^* - \theta^L) + (p - c_A)\left(1 - \frac{p}{m}\right) \quad (8.23)$$

A maximizes the profit subject to the constraints of positive demands in both segments:

$$\begin{aligned}\max_{p, \delta} \Pi_{PD}^A \quad \text{s. t.} \quad & \frac{q_l}{m} > \delta \\ & 1 > \theta^*\end{aligned}\quad (8.24)$$

The optimal price p_{PD} and inverse discount δ_{PD} resulting from the Lagrange optimization are:

$$\begin{aligned}p_{PD} &= \frac{m(4mq_l(m + \gamma) + c_A(mq_l(4 + \gamma) + \gamma(3q_l - (1 - q_l)\gamma)))}{8m^2q_l + m(8q_l - \gamma)\gamma + q_l\gamma^2} \\ \delta_{PD} &= \frac{q_l(m(2q_l + c_A(5q_l - 2))\gamma + 2m^2(2(1 + c_A)q_l + \gamma) + c_A\gamma(q_l - (1 - q_l)\gamma))}{m(4mq_l(m + \gamma) + c_A(mq_l(4 + \gamma) + \gamma(3q_l - (1 - q_l)\gamma))}\end{aligned}\quad (8.25)$$

There is a positive demand for both goods as long as $c'_A < c_A < c''_A$:

$$\begin{aligned}
c_A' &= \frac{m(m-q_l)\gamma}{2mq_l(1-m) + (m+q_l-2mq_l)\gamma} \\
c_A'' &= \frac{(m-q_l)(4m^2q_l + 6mq_l\gamma + (m+q_l)\gamma^2)}{m^2q_l(4-4q_l-3\gamma) + q_l\gamma((3-q_l)\gamma - q_l) + m\gamma(\gamma + q_l(9-5q_l-3\gamma))}
\end{aligned} \tag{8.26}$$

Firm A earns the profit:

$$\begin{aligned}
\Pi_{PD}^A &= \frac{2q_l(m+\gamma)}{(m-q_l)(8m^2q_l + m(8q_l-\gamma)\gamma + q_l\gamma^2)} \\
&\quad \cdot [2m^2(m-q_l) - c_A(m-q_l)(m(4-\gamma) + \gamma) \\
&\quad + c_A^2(m^2q_l + m(1-q_l)(2-\gamma) + \gamma - q_l(1+\gamma))]
\end{aligned} \tag{8.27}$$

Meanwhile, a type-B monopolist gets a profit Π_{PD}^B :

$$\begin{aligned}
\Pi_{PD}^B &= (p - c_Bq_l)(1 - \theta^*) + (\delta p - c_Bq_l)(\theta^* - \theta^L) \\
&\quad + (p - c_Bq_l)\left(1 - \frac{p}{m}\right) \\
\Pi_{PD}^B &= \frac{2q_l(m+\gamma)}{(m-q_l)(8m^2q_l + m(8q_l-\gamma)\gamma + q_l\gamma^2)} \\
&\quad + [(m-q_l)(2m(m-2c_Bq_l) + c_B(m-q_l)\gamma + c_Ac_B(-\gamma + q_l(2+2m+\gamma))) \\
&\quad - c_A^2(-q_l + m^2q_l + m(1-q_l)(2-\gamma) + (1-q_l)\gamma)]
\end{aligned} \tag{8.28}$$

Consumers' belief that the monopolist has low costs is given by $\tilde{\mu}$, $0 \leq \tilde{\mu} \leq 1$, and in the pooling equilibrium, $\tilde{\mu} = \mu$. The price p_{PD} and the discount δ_{PD} constitute a pooling equilibrium only if no type has an incentive to deviate. Consumers observing a different price than the equilibrium choices are assumed to believe $\tilde{\mu} = 0$. Given these off-equilibrium beliefs, the resulting profit for A is:

$$\Pi_{q_l}^A = \frac{(1-c_A)^2 q_l}{2} \tag{8.29}$$

For $c_A^{L*} < c_A < c_A^{L**}$, A actually does have an incentive to deviate from the equilibrium strategy:

$$\begin{aligned}
c_A^{L*} &= \frac{E - \sqrt{E^2 - 4(m - q_l)^2 (8m^2 + 8m\gamma + \gamma^2) D}}{2D} \\
c_A^{L**} &= \frac{E + \sqrt{E^2 - 4(m - q_l)^2 (8m^2 + 8m\gamma + \gamma^2) D}}{2D}
\end{aligned} \tag{8.30}$$

with

$$\begin{aligned}
D &= 4m(-q_l + m(2 - (2 + m - 2q_l)q_l)) \\
&\quad + 4(-q_l + m(3 - m - (3 - 2q_l)q_l))\gamma + (2 - m - q_l)^2\gamma^2 \\
E &= 2(m - q_l)(8m^2(1 - q_l) + 2m(5 - m - 4q_l)\gamma + (2 - m - q_l)\gamma^2)
\end{aligned}$$

An analysis of parameter constellation shows that $c_A^{L*} < c_A''$, so that price discrimination only constitutes an attractive equilibrium strategy for A in the interval $c_A < c_A^{L*}$.

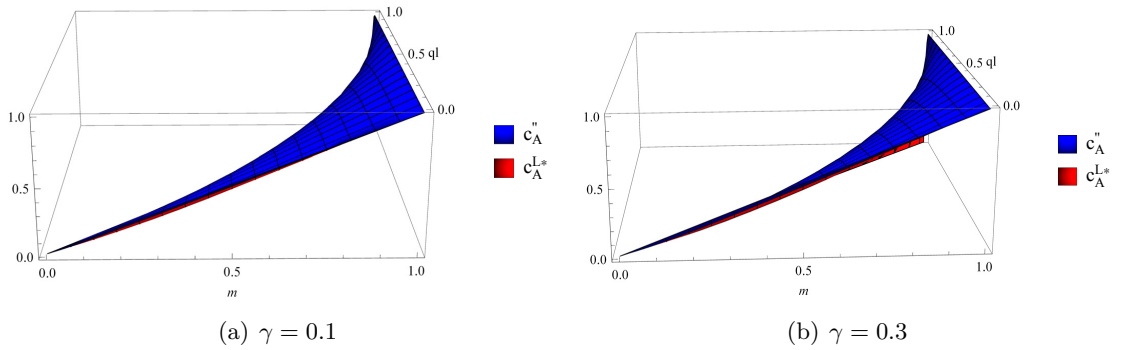


Fig. 8.3: Comparison of Critical Values c_A^{L*} and c_A''

B's profit from setting $p = p_{q_l}^A$ increases in the off-equilibrium belief $\tilde{\mu}$, so the highest profit is realized for $\tilde{\mu} = 1$:

$$\Pi_{q_l}^B(p_{q_l}^A) = \frac{(3 - (1 - q_l)c_A - q_l)q_l(1 + c_A - 2c_B)}{4} \tag{8.31}$$

This profit is smaller than the equilibrium payoff for $c_A^{B*} < c_A < c_A^{B**}$:

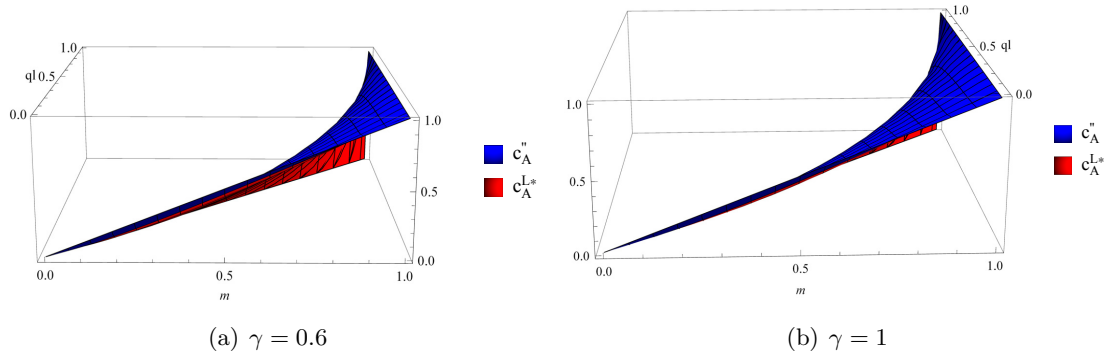


Fig. 8.4: Comparison of Critical Values c_A^{L*} and c_A''

$$\begin{aligned}
 c_A^{B*} &= \frac{1}{2G} \cdot \left[-F \right. \\
 &\quad - \left(F^2 + 4G \left((m - q_l) (8m(m + \gamma) (2m - q_l (3 - 2c_B (1 - q_l) - q_l)) \right. \right. \\
 &\quad \left. \left. + (m - q_l) (8c_B m + (3 + 2c_B (1 + q_l) - q_l) \gamma) \gamma) \right) \right)^{\frac{1}{2}} \left. \right] \\
 c_A^{B**} &= \frac{1}{2G} \cdot \left[-F \right. \\
 &\quad + \left(F^2 + 4G \left((m - q_l) (8m(m + \gamma) (2m - q_l (3 - 2c_B (1 - q_l) - q_l)) \right. \right. \\
 &\quad \left. \left. + (m - q_l) (8c_B m + (3 + 2c_B (1 + q_l) - q_l) \gamma) \gamma) \right) \right)^{\frac{1}{2}} \left. \right]
 \end{aligned} \tag{8.32}$$

with

$$\begin{aligned}
 F &= 2(m - q_l) \left((1 - q_l) (8m^2 q_l + m (8q_l - \gamma) \gamma + q_l \gamma^2) \right. \\
 &\quad \left. + c_B (-8m q_l (1 - m q_l) + 4(m - (2 + m) q_l + 2m q_l^2) \gamma + (4 - m - (3 + m) q_l + q_l^2) \gamma^2) \right) \\
 G &= -8q_l (m + \gamma) + (8 + m^2 (1 + q_l) - 2m (4 - (3 - q_l) q_l) - q_l (8 - q_l - q_l^2)) \gamma^2 \\
 &\quad + 8m (-m^2 q_l^2 + m (2 - (1 - q_l) q_l (2 + q_l - \gamma) - \gamma) + (3 - q_l (3 - q_l - q_l^2)) \gamma)
 \end{aligned}$$

For $c_A^{B*} < c_A < c_A^{B**}$, B has no incentive to deviate from the equilibrium price and discount.

In order to rule out implausible equilibria, the Intuitive Criterion is applied. The belief

$\tilde{\mu} = 0$ is inconsistent for the two prices p_{S1}^A and p_{S2}^A , because only A could have an incentive to deviate. The equilibrium is plausible if:

$$\begin{aligned}\Pi_{PD}^A &\geq \Pi_{S1}^A \\ \Pi_{PD}^A &\geq \Pi_{S2}^A\end{aligned}\tag{8.33}$$

The first equation is solved by the two values c_A^{S1*} and c_A^{S1**} :

$$\begin{aligned}c_A^{S1*} &= \frac{1}{L} \cdot \left[- (m - q_l) (1 + q_l)^2 (B c_A^* - \gamma (2m^2 q_l - m (2q_l (1 - \gamma) + \gamma) - \gamma q_l)) \right. \\ &\quad - \left((m - q_l) (1 + q_l)^2 \left(-L \left(-8m^2 (m + \gamma) q_l + B (1 - (c_A^*)^2) \right) \right) \right. \\ &\quad \left. \left. + (m - q_l) (1 + q_l)^2 (B c_A^* - \gamma (2m^2 q_l - m (2q_l (1 - \gamma) + \gamma) - \gamma q_l))^2 \right) \right]^{\frac{1}{2}}\end{aligned}\tag{8.34}$$

$$\begin{aligned}c_A^{S1**} &= \frac{1}{L} \cdot \left[- (m - q_l) (1 + q_l)^2 (B c_A^* - \gamma (2m^2 q_l - m (2q_l (1 - \gamma) + \gamma) - \gamma q_l)) \right. \\ &\quad + \left((m - q_l) (1 + q_l)^2 \left(-L \left(-8m^2 (m + \gamma) q_l + B (1 - (c_A^*)^2) \right) \right) \right. \\ &\quad \left. \left. + (m - q_l) (1 + q_l)^2 (B c_A^* - \gamma (2m^2 q_l - m (2q_l (1 - \gamma) + \gamma) - \gamma q_l))^2 \right) \right]^{\frac{1}{2}}\end{aligned}\tag{8.35}$$

with $B = 8m^2 q_l + m (8q_l - \gamma) \gamma + q_l \gamma^2$

and $L = -4q_l (1 + q_l)^2 (m + \gamma) (m^2 q_l + m (1 - q_l) (2 - \gamma) + \gamma - q_l (1 + \gamma))$

For $c_A < c_A^{S1*}$ and $c_A > c_A^{S1**}$, A has no incentive to deviate from the equilibrium with price discrimination to p_{S1}^A given consumer beliefs $\tilde{\mu} = 1$. The second equation is solved by c_A^{S2*} and c_A^{S2**} :

$$\begin{aligned}
c_A^{S2*} = \frac{1}{L} \cdot & \left[- (m - q_l) (1 + q_l)^2 (B c_A^{**} - \gamma (2m^2 q_l - m (2q_l (1 - \gamma) + \gamma) - \gamma q_l)) \right. \\
& - \left((m - q_l) (1 + q_l)^2 \left(-L \left(-8m^2 (m + \gamma) q_l + B \left(1 - (c_A^{**})^2 \right) \right) \right. \right. \\
& \left. \left. + (m - q_l) (1 + q_l)^2 (B c_A^{**} - \gamma (2m^2 q_l - m (2q_l (1 - \gamma) + \gamma) - \gamma q_l))^2 \right) \right)^{\frac{1}{2}} \left. \right]
\end{aligned} \tag{8.36}$$

$$\begin{aligned}
c_A^{S2**} = \frac{1}{L} \cdot & \left[- (m - q_l) (1 + q_l)^2 (B c_A^{**} - \gamma (2m^2 q_l - m (2q_l (1 - \gamma) + \gamma) - \gamma q_l)) \right. \\
& + \left((m - q_l) (1 + q_l)^2 \left(-L \left(-8m^2 (m + \gamma) q_l + B \left(1 - (c_A^{**})^2 \right) \right) \right. \right. \\
& \left. \left. + (m - q_l) (1 + q_l)^2 (B c_A^{**} - \gamma (2m^2 q_l - m (2q_l (1 - \gamma) + \gamma) - \gamma q_l))^2 \right) \right)^{\frac{1}{2}} \left. \right]
\end{aligned} \tag{8.37}$$

Again, A has no incentive to deviate from the equilibrium for either $c_A < c_A^{S2*}$ or $c_A > c_A^{S2**}$. Combining this restriction with the other one given above implies that the pooling equilibrium is intuitive for the medium range, $c_A^{S1**} < c_A < c_A^{S2*}$.

Q.E.D.

8.1.7 Proof of Proposition 6

If both firms pool and A sells high quality, consumers expect a medium quality $m = \mu q_h + (1 - \mu) q_l$. The profit of A is:

$$\Pi_P^A = 2(p - c_A) \left(1 - \frac{p}{m} \right) \tag{8.38}$$

The optimal price and the resulting profit for A are:

$$\begin{aligned}
p_P &= \frac{m + c_A}{2} \\
\Pi_P^A &= \frac{(m - c_A)^2}{2m}
\end{aligned} \tag{8.39}$$

Setting the price p^P , the high cost monopolist earns:

$$\begin{aligned}\Pi_P^B &= (p - c_B q_l) \left(1 - \frac{p}{m} + 1 - \frac{p}{q_l}\right) \\ &= \frac{(c_A + m - 2c_B q_l)(m(3q_l - m) - c_A(m + q_l))}{4mq_l}\end{aligned}\quad (8.40)$$

which is positive for $c_B \leq \frac{c_A + m}{2q_l}$ and $c_A \leq \frac{m(3q_l - m)}{m + q_l}$.

This constitutes a pooling equilibrium if no type has an incentive to deviate. Assume that consumers observing deviations expect low quality with certainty, $\tilde{\mu} = 0$. Given these beliefs, the maximum profit of type A is:

$$\Pi_{q_L}^A = \frac{(1 - c_A)^2 q_L}{2}\quad (8.41)$$

Solving the equation $\Pi_P^A \geq \Pi_{q_L}^A$ yields two solutions, $c_A^{L'}$ and $c_A^{L''}$

$$\begin{aligned}c_A^{L'} &= \frac{(1 - q_l)m - \sqrt{(1 - m)^2 m q_l}}{1 - m q_l} \\ c_A^{L''} &= \frac{(1 - q_l)m + \sqrt{(1 - m)^2 m q_l}}{1 - m q_l}\end{aligned}\quad (8.42)$$

Note that $c_A^{L''} > m$:

$$m - c_A^{L''} = \frac{(1 - m)(m q_l - \sqrt{m q_l})}{1 - m q_l} < 0\quad (8.43)$$

For $c_A > m$, A has a negative profit margin from pooling. As a consequence, type A has no incentive to deviate from the pooling equilibrium for $c_A < c_A^{L'}$.

If B deviates with $p = p_{q_L}^A$, the highest profit is obtained for $\tilde{\mu} = 1$. B then earns:

$$\Pi = \frac{1}{2}(1 + c_A - 2c_B)(3 - c_A - q_l - c_A q_l) q_l\quad (8.44)$$

It has no incentive to reveal its type for $c_A^{B'} < c_A < c_A^{B''}$:

$$\begin{aligned}
c_A^{B'} &= \frac{-G - \sqrt{G^2 - 2Hm(m^2 - 3mq_l + (3 - q_l)q_l^2 - 2c_Bq_l(m - q_l^2))}}{H} \\
c_A^{B''} &= \frac{-G + \sqrt{G^2 - 2Hm(m^2 - 3mq_l + (3 - q_l)q_l^2 - 2c_Bq_l(m - q_l^2))}}{H}
\end{aligned} \tag{8.45}$$

with

$$\begin{aligned}
G &= 2(m(m - q_l(1 - q_l + q_l^2)) - c_Bq_l(q_l + m(1 - q_l - q_l^2))) \\
H &= 2(q_l + m(1 - q_l^2 - q_l^3))
\end{aligned}$$

Again, the equilibrium needs to be plausible. For the prices $p_{S_1}^A$ and $p_{S_2}^A$, consumer beliefs off the equilibrium path with $\tilde{\mu} = 0$ are inconsistent, since only A has an incentive to deviate. It must be shown that

$$\begin{aligned}
\Pi_P^A &\geq \Pi_{S_1}^A \\
\Pi_P^A &\geq \Pi_{S_2}^A
\end{aligned} \tag{8.46}$$

The first equation is solved with $c_A^{S_1'}$ and $c_A^{S_1''}$:

$$\begin{aligned}
c_A^{S_1'} &= mc_A^* - \sqrt{m(1 - (c_A^*)^2)(1 - m)} \\
c_A^{S_1''} &= mc_A^* + \sqrt{m(1 - (c_A^*)^2)(1 - m)}
\end{aligned} \tag{8.47}$$

A indeed makes a higher profit from uniform pricing and pooling for $c_A < c_A^{S_1'}$ or $c_A > c_A^{S_1''}$. Similarly, the second equation yields the solutions $c_A^{S_2'}$ and $c_A^{S_2''}$:

$$\begin{aligned}
c_A^{S_2'} &= mc_A^{**} - \sqrt{m(1 - (c_A^{**})^2)(1 - m)} \\
c_A^{S_2''} &= mc_A^{**} + \sqrt{m(1 - (c_A^{**})^2)(1 - m)}
\end{aligned} \tag{8.48}$$

The profit from separating is higher for $c_A^{S2'} < c_A < c_A^{S2''}$, so that A has no incentive to deviate for $c_A < c_A^{S2'}$ or $c_A > c_A^{S2''}$. Taking these conditions together, a pooling equilibrium with uniform pricing is only plausible for $c_A^{S1''} < c_A < c_A^{S2'}$.

Q.E.D.

8.1.8 Proof: $\Pi_{PD}^A \geq \Pi_P^A$

Type A is always better off under price discrimination and pooling than under uniform pricing and pooling:

$$\Pi_{PD}^A - \Pi_P^A = \frac{(2c_A(1-m)mql - (m(m-ql) - c_A(ql + m(1-2ql)))\gamma)^2}{2m(m-ql)(8m^2ql + m(8ql - \gamma)\gamma + ql\gamma^2)} > 0 \quad (8.49)$$

Q.E.D.

8.2 Duopoly with Exogenous Quality

8.2.1 Proof of Proposition 7

If both firms have the same costs $c_A = c_B \equiv c$ and sell q_l , they set $p = cq_l$ and earn zero profits. Contrarily, if they differentiate in qualities, their profit functions are:

$$\begin{aligned} \Pi_D^A &= 2(p_A - c)(1 - \theta^*) \\ \Pi_D^B &= 2(p_B - cq_l)(\theta^* - \theta^L) \end{aligned} \quad (8.50)$$

Marginal consumers are reflected by θ^* and θ^L :

$$\begin{aligned} \theta^* &= \frac{p_D^A q_l (1 + \gamma) - p_D^B (q_l + \gamma)}{(1 - q_l)} \\ \theta^L &= \frac{p_D^B}{q_l} \end{aligned} \quad (8.51)$$

Profits are maximized with:

$$\begin{aligned}
p_D^A &= \frac{2(1 - q_l) + c(2 + q_l + 3\gamma)}{4 - q_l + 3\gamma} \\
p_D^B &= \frac{q_l(1 - q_l + 3c(1 + \gamma))}{4 - q_l + 3\gamma}
\end{aligned} \tag{8.52}$$

$$\begin{aligned}
\Pi_D^A &= \frac{8(1 - c)^2(1 - q_l)(1 + \gamma)}{(4 - q_l + 3\gamma)^2} \\
\Pi_D^B &= \frac{2(1 - c)^2(1 - q_l)q_l(1 + \gamma)}{(4 - q_l + 3\gamma)^2}
\end{aligned} \tag{8.53}$$

Since both profits are strictly positive, both firms are better off from differentiating in qualities than providing only q_l and engage in fierce price competition.

If A wants to offer both high and low quality, the price for low quality would be reduced to $p = cq_l$, resulting in zero profits for both firms from selling q_l . Moreover, the low price exerts a downward pressure on the high quality good:

$$p_{PD}^A = \frac{1 - q_l + c(1 + q_l + 2\gamma)}{2(1 + \gamma)} \tag{8.54}$$

The profit of A is:

$$\Pi_{PD}^A = \frac{(1 - c)^2(1 - q_l)}{2(1 + \gamma)} < \Pi_D^A \tag{8.55}$$

Q.E.D.

8.2.2 Proof of Proposition 8

If A price discriminates and becomes the sole supplier, the profit function is¹:

$$\Pi_{PD}^A = (p_{PD,H}^A - c_A)(1 - \theta^*) + (p_{PD,L}^A - c_A q_l)(\theta^* - \theta^L) + (p_{PD,H}^A - c_A)(1 - p^H) \tag{8.56}$$

The optimal prices for the two goods are:

¹ Note that the marginal consumers θ^* and θ^L are the same as in Equation 8.51.

$$p_{PD,H}^A = \frac{2 + c_B\gamma + c_A(1 - q_l)(2 + \gamma) - q_l(2 - c_B(2 + \gamma))}{2(2 - q_l + \gamma)} \quad (8.57)$$

$$p_{PD,L}^A = c_B q_l$$

A's profit from driving B out of the market by offering two goods is:

$$\begin{aligned} \Pi_{PD}^A = & \frac{1}{4(2 - q_l + \gamma)} \cdot [4(1 - c_A)^2 + \gamma^2(c_B - c_A)^2(1 - q_l) \\ & - 4((1 - c_B)^2 + (c_B - c_A)^2)q_l + 4\gamma(c_B - c_A)(1 - c_A(1 - q_l) + q_l - 2c_B q_l)] \end{aligned} \quad (8.58)$$

The price discrimination is feasible for $c_A > c_A^*$:

$$c_A^* = \frac{-2 + 4c_B + c_B\gamma}{2 + \gamma} \quad (8.59)$$

Firm A could also become a monopolist by selling high quality or low quality only. The corresponding profits are:

$$\begin{aligned} \Pi_{M,q_h}^A &= 2(1 - c_B)(c_B - c_A) \\ \Pi_{M,q_l}^A &= 2(1 - c_B)(c_B - c_A)q_l \end{aligned} \quad (8.60)$$

Firm A prefers the price discrimination to providing high quality only:

$$\Pi_{PD}^A - \Pi_{M,q_h}^A = \frac{(1 - q_l)(2 + c_A(2 + \gamma) - c_B(4 + \gamma))^2}{4(2 - q_l + \gamma)} > 0 \quad (8.61)$$

Now it only needs to be shown that price discrimination dominates a differentiation strategy where A sells q_h while B sells q_l . This strategy would yield the profit:

$$\Pi_D^A = \frac{2(1 + \gamma)(2 - (2 - c_B)q_l + c_B\gamma - c_A(2 - q_l + \gamma))^2}{(1 - q_l)(4 - q_l + 3\gamma)^2} \quad (8.62)$$

Note that the differentiation strategy is only feasible for $c_A > c_A^S$:

$$c_A^S = \frac{-(1-q_l) + c_B(2-q_l+\gamma)}{1+\gamma} > c_A^* \quad (8.63)$$

Solving the equation $\Pi_{PD}^A = \Pi_D^A$ yields two solutions, c_A^1 and c_A^2 :

$$\begin{aligned} c_A^1 &= \frac{d + 4(1-c_B)(1-q_l)(4-q_l+3\gamma) \sqrt{q_l(1+\gamma)(2-q_l+\gamma)(q_l^2+\gamma^2+2q_l(1+\gamma(3+\gamma)))}}{-B} \\ c_A^2 &= \frac{d - 4(1-c_B)(1-q_l)(4-q_l+3\gamma) \sqrt{q_l(1+\gamma)(2-q_l+\gamma)(q_l^2+\gamma^2+2q_l(1+\gamma(3+\gamma)))}}{-B} \end{aligned} \quad (8.64)$$

with

$$\begin{aligned} d &= \gamma^2(2+\gamma)(2+c_B\gamma) + q_l^4(-2\gamma+c_B(4+\gamma(6+\gamma))) \\ &\quad - 2q_l^3(-2(3+\gamma(8+3\gamma)) + c_B(22+\gamma(4+\gamma)(11+3\gamma))) \\ &\quad - 2q_l(-4(4+\gamma(11+2\gamma(4+\gamma))) + c_B(3+\gamma)(16+\gamma(40+\gamma(32+9\gamma)))) \\ &\quad + q_l^2(-2(22+\gamma(59+\gamma(40+9\gamma))) + c_B(128+\gamma(322+\gamma(269+9\gamma(10+\gamma)))) \end{aligned}$$

Price discrimination yields a higher profit for A if $c_A^1 < c_A < c_A^2$. It can be shown that $c_A^2 > c_B$ and $c_A^1 < c_A^S$ by restructuring the differences in the critical values:

$$\begin{aligned} c_A^1 - c_A^S &= -\frac{(1-c_B)(1-q_l)(4-q_l+3\gamma)}{(1+\gamma)B} \\ &\quad \cdot \underbrace{\left(C + 4(1+\gamma) \sqrt{q_l(2-q_l+\gamma)(1+\gamma)(q_l^2+\gamma^2+2q_l(1+\gamma(3+\gamma)))} \right)}_X \end{aligned} \quad (8.65)$$

$$\begin{aligned} c_B - c_A^2 &= -\frac{2(1-c_B)(1-q_l)}{B} \\ &\quad \cdot \underbrace{\left(-A + 2(4-q_l+3\gamma) \sqrt{q_l(2-q_l+\gamma)(1+\gamma)(q_l^2+\gamma^2+2q_l(1+\gamma(3+\gamma)))} \right)}_Y \end{aligned} \quad (8.66)$$

with

$$\begin{aligned}
A &= q_l^3 \gamma + \gamma^2 (2 + \gamma) - 3q_l^2 (2 + \gamma) (1 + 2\gamma) + q_l (16 + \gamma (44 + \gamma (34 + 9\gamma))) \\
B &= - (q_l^4 + \gamma^2 - 2q_l (8 + 3\gamma (5 + 3\gamma))) (2 + \gamma)^2 - 3q_l^2 (2 + \gamma) (14 + 3\gamma (3 + \gamma)^2) \\
&\quad + 2q_l^3 (16 + \gamma (28 + \gamma (17 + 3\gamma))) > 0 \\
C &= \gamma^2 (2 + \gamma) - q_l^3 (2 + \gamma)^2 - q_l (8 + 5\gamma (2 + \gamma)) + q_l^2 (16 + \gamma (26 + \gamma (16 + 3\gamma)))
\end{aligned}$$

This allows to plot the important terms B , X and Y :

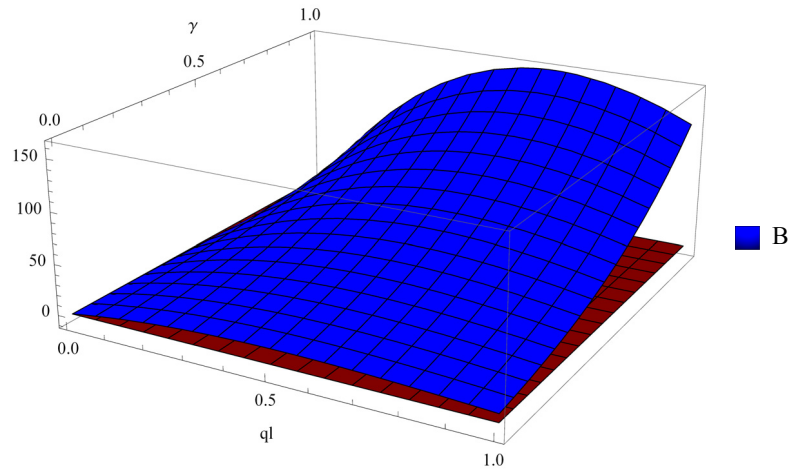


Fig. 8.5: Value of B

Plotting the terms of X and Y further points out that $c_A^1 < c_A^S$ and $c_B < c_A^2$:

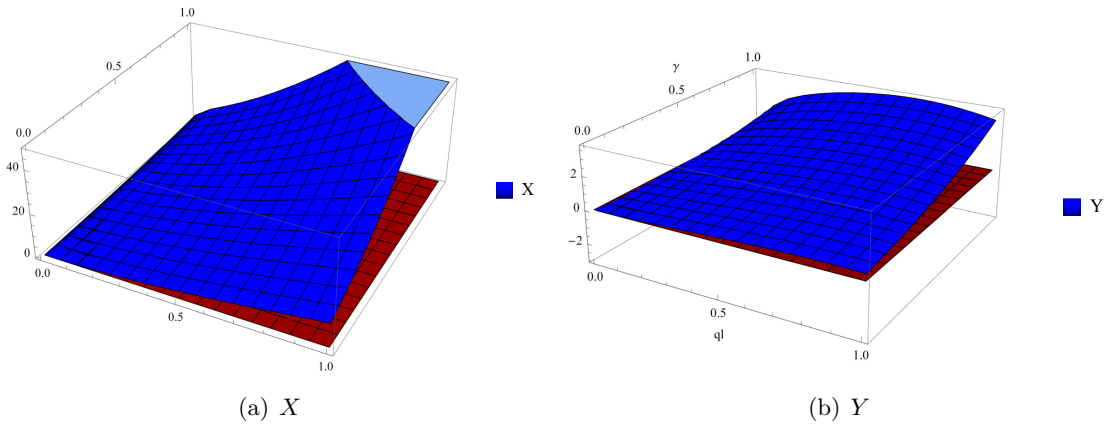


Fig. 8.6: Overview on the Terms X and Y

Q.E.D.

8.2.3 Proof of Proposition 9

A is always better off to become a monopolist by offering two goods. However, for $c_A < c_A^*$, price discrimination is not feasible. Becoming a monopolist by selling high quality at a low price needs to yield a higher profit for A than differentiating and letting B sell low quality:

$$\Pi_M^A > \Pi_D^A \quad (8.67)$$

The equation is solved for c_A^1 and c_A^S . Becoming a monopolist with high quality is more profitable for $c_A^1 < c_A < c_A^S$. Since the differentiating strategy is only feasible for $c_A < c_A^S$, driving B out of the market by selling q_h at a low price is an equilibrium for $0 < c_A < c_A^*$, as $c_A^* < c_A^S$.

Q.E.D.

8.3 Duopoly with Endogenous Quality

8.3.1 Proof of Proposition 10

The optimal quality q_2^B is obtained by maximizing the profit with respect to q_2^B . Contrarily, the profit of Firm A increases in the quality q_2^A :

$$\frac{\partial \Pi^A}{\partial q_2^A} = \frac{7(2q_2^A - \gamma)(q_1^A + \gamma)(2q_2^A\gamma + q_1^A(2q_2^A + \gamma))}{12(4q_1^A q_2^A + \gamma(4q_2^A - \gamma))^2} \quad (8.68)$$

This is positive as long as $2q_2^A > \gamma$. The condition is fulfilled for the maximum value of $q_2^A = 1$. The profit of Firm A further increases in q_1^A :

$$\frac{\partial \Pi^A}{\partial q_1^A} = \frac{1}{48} \left(-\frac{5(q_1^A)^2}{(q_1^A + \gamma)^2} + \frac{10q_1^A}{q_1^A + \gamma} + \frac{28(1 + 2q_1^A - \gamma)}{4q_1^A + (4 - \gamma)\gamma} - \frac{112(1 + q_1^A)(q_1^A + \gamma)}{(4q_1^A + (4 - \gamma)\gamma)^2} \right) \quad (8.69)$$

The derivative is always positive, as illustrated by the Figure 8.7.

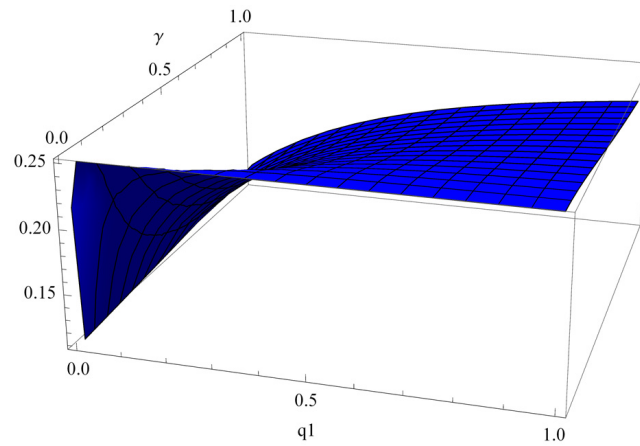


Fig. 8.7: $\frac{\partial \Pi^A}{\partial q_1}$

As a result, Firm A sets the maximum level of quality in both markets, $q_1^A = q_2^A = 1$.

Q.E.D.

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